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THE ETIOLOGY OF "LOUPING-ILL."

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"LOUPING-ILL" is responsible for most of the mortality on hill sheep farms in certain areas of Scotland and the border counties of England. It has been discussed by various authors for more than a century, and during the last forty years several attempts have been made to ascertain its nature.

The farms in the affected areas are known as "diseased" farms, and, presumably, the existence of the regular heavy losses has been responsible for the adoption of special customs which apply both to the transfer of the farms and to the system of husbandry followed.

When these farms change hands it is customary for the sheep stock to be taken over with them, as it would be unsafe to restock from ordinary farms because sheep which are not "acclimatised" suffer a high death rate when placed on "louping-ill" land; on these farms the sheep are spoken of as "bound to the ground." At the valuation of the sheep a special "acclimatisation value" is allowed, and this is additional to the fair market price of the stock at the time of transfer.

Presumably, the introduction of these customs is the result of bitter experience suffered for generations, and is an attempt to

minimise the losses. The successful farmers in the affected areas have learnt how to get the best possible results in the circumstances, but the death rate is always very high, and in some years it is appalling.

There are two " louping-ill " seasons. The heaviest mortality occurs in the spring and early summer, and there is a shorter season with smaller losses in the autumn. While most of the cases occur in lambs and yearlings, the highest death rate occurs in rams brought in for the purpose of improving the stock by the introduction of new blood.

The advantages to be obtained by the introduction of rams possessing particular characters or lineage often outweigh the risk of early death. When such rams are purchased, however, they are treated with great care, and are commonly boarded by the vendor until the autumn " louping-ill " season is over ; when brought to the affected farm they are usually housed at first and are accustomed to the conditions of hill pasture with the greatest possible caution, as, although such treatment has disadvantages, experience has shown that it lessens the risks of infection. Animals that have survived a season are considered to be relatively immune.

The Teviotdale Farmers' Club instituted an inquiry into the causation of " louping-ill " in 1879, and, as the result of its ventilation of the question, the Highland and Agricultural Society appointed a Committee in 1881 to study the disease. This Committee issued three reports, but it did not make any progress towards solving the problem.

M'Fadyean (1894 and 1900) cleared up a great many of the misconceptions that had arisen and pointed out that the bacteriological work reported by different authors was worthless, as it had not been properly carried out. In the course of discussing the nature of the disease, he said :

" Without attempting to decide which of them has the best claim to the name, I feel warrented in saying that the following are the principal morbid conditions at the present time grouped under the head of ' louping-ill ' :

" 1. Pyæmic spinal meningitis, caused by pyogenic bacteria.
" 2. Gastritis and enteritis from the indigestible substances (wool, sand, dried grass) in the stomach or intestines.
" 3. Disorders of brain functions, paralysis, and general weakness, with, in some cases, excess of cerebro-spinal fluid in the cranial cavity, but without gross lesions in any of the organs of the body.

" The first two of these conditions cover most of the cases of ' louping-ill ' in lambs, and the third includes the bulk of the cases in adult sheep."

In the experience of the writers, there are a good many cases in lambs in which there is an absence of gross lesions that can be regarded as responsible for the illness. With this exception, the above definition covers the types of illness shown to them as examples of " louping-ill."

A departmental committee was appointed in 1900 to deal with the question, but its report (1905) repeated the errors committed by most of the earlier investigators. M'Gowan (1915) incriminated a bacillus, but this cannot be demonstrated when correct bacteriological technique is employed, and his views concerning the etiology of the disease must be regarded as quite erroneous and unsupported by evidence.

Stockman (1916, 1918, 1919, 1924 and 1925) made an extensive investigation. In the work covered by his first report he obtained negative results ; later, he considered that, by means of inoculations with tissues from natural cases, he had reproduced the disease artificially in the form of a febrile reaction without visible illness or, in odd cases, as an actual paralysis. He also considered that he had transmitted the disease through the agency of Ixodes ricinus, the common tick of " louping-ill " pastures.

The work undertaken in the laboratory of the Animal Diseases Research Association at Glasgow did not support Stockman's results, as inoculations carried out did not lead to the onset of the disease in healthy sheep. This work corroborated certain of the results of previous investigators.

During the last decade " louping-ill " has been regarded, in Scotland, as an important unsolved problem, and there have been many references to it in these terms in official publications.

Those responsible for replying to enquiries concerning the prevention of the disease have been compelled to say that, as its nature is unknown, it is impossible to advise the adoption of measures other than those now in force as the ordinary system of husbandry of the affected areas.

Programme of the Investigation.

After reviewing the conditions in which " louping-ill " occurs in Scotland, and summarising the general knowledge of the various factors related to its causation, a programme including the following special lines of investigation was drawn up :

1. To remove the ticks from in-lamb ewes from badly " affected " land and to allow the ewes to lamb on " clean " ground which is free from ticks.

2. To lamb " clean " ewes on badly " affected " pastures.

These two experiments were designed to produce data which, on comparison, would give an indication of the extent to which certain factors connected with the land are related to the disease.

3. To clear ticks from a selected area of " affected " land, and to compare the effects of placing native stock from " affected " farms and also " clean " stock on the land cleared of ticks and on " affected " land.

4. To feed " clean " sheep on mixed herbage cut from " affected " pasture.

5. To expose " clean " adult sheep on " affected " pastures.
   (*a*) Muzzled.
   (*b*) Protected from tick bites.
   (*c*) Controls.

6. To inoculate into healthy sheep, pigs, and other animals various tissues and fluids from the bodies of " affected " sheep.

7. To ascertain the effect of placing ticks from " affected " sheep on to " clean " sheep, due allowance being made for the various factors such as stages in the metamorphosis, intervals following feeds on " affected " hosts, etc.

8. To carry out a detailed survey of the occurrence of the disease in the county of Selkirkshire.

   A map showing the boundaries of every farm in the County was prepared, and arrangements were made for farm to farm visits within the County.

Each of these headings was dealt with in considerable detail, and an elaborate series of experiments was planned in which provision was made for the various factors which would operate.

A great deal of the preliminary work involved in this programme was carried out during 1929, but the present report only deals with the results of certain of the inoculation experiments.

The Susceptibility of Pigs.

Certain authors have stated that pigs are susceptible to the disease, and this is recognised in some of the typical " louping-ill " areas in Scotland although, curiously enough, in other equally typical " louping-ill " areas the disease has never been known to occur in pigs.

When the possibility of undertaking a comprehensive investigation was being explored in 1927 and 1928, one set of experiments was carried out to ascertain if pigs would be likely to serve as useful test animals. Three pigs were fed separately on nervous tissue (brain and spinal cord), voluntary muscle, and alimentary tract contents from natural cases of " louping-ill." These animals remained healthy. A suspension of the dorsal portion of the spinal cord from an " affected " sheep was inoculated subcutaneously into another pig, and two days later this pig was re-inoculated subcutaneously with similar material from another case. After remaining in perfect health for some days, the pig developed a febrile temperature, and on the fourteenth day after the first inoculation (twelve days after the second inoculation) it became visibly ill. It showed violent tremors, involving the whole body, was huddled up against the wall of the loose box, and was unable to rise ; when helped to its feet it was able to stand but refused food. The acute illness lasted for five days. Quite early in the illness the muscles of the neck became partially paralysed, and the pig was unable to lift its snout more than an inch or two from the ground. Recovery was rapid after the acute stage of the illness passed, but the affection of the neck muscles remained. The animal was kept under observation for a year, and even at the end of that

time it could only lift its snout about eight or nine inches from the ground, although it was otherwise in perfect health and condition.

These experiments were, of course, carried out on such a small scale that no conclusions could be drawn from the negative results obtained from the feeding tests, but the result obtained with the inoculated pig was interesting.

Inoculation Experiments Carried Out in 1929.

Field Laboratory.

In the course of arranging the preliminary stages of the work to be carried out in 1929, the writers had frequent discussions with Mr. Andrew Linton, B.SC., Gilmanscleuch, Selkirk, who was keenly interested in the disease, and a field laboratory was set up on his farm for about two months from the end of April. Gilmanscleuch is in a very typical area of " louping-ill " country in the middle of the Ettrick valley.

In the absence of cultivable micro-organisms and of cheaper experimental animals than sheep or pigs, the execution of large-scale transmission experiments would ordinarily be a very expensive matter. An appeal was made for lambs, and it is perhaps worthy of record that over three hundred were presented by sheep farmers, and that many more could have been obtained if more accommodation had been available.

Arrangements were made to inoculate intracerebrally sets of two pigs, two sheep, two rabbits, and two guinea-pigs from selected cases of " louping-ill " dealt with at the field laboratory. The intracerebral route was chosen because the survey of the work carried out by other authors had indicated that inoculations by the commoner routes were likely to yield negative results, and because this route appeared to offer the greatest opportunity to demonstrate any infective agent present in a disease in which nervous symptoms are the dominating feature.

Production of the Disease in Sheep and Pigs.

Definite illness was produced in the sheep and pigs inoculated from Ewe 5 and Lamb 29-14, two of the natural cases selected for study.

The disease was propagated continuously from one animal to another in order to maintain the " infective agent " and, at the same time, sets of experiments involving the inoculation of different series of animals were carried out with the " virus " from Ewe 5 in order to study its nature.

Tables I, II and III show the results of different series of intracerebral inoculations into sheep and pigs with suspensions prepared from brain and spinal cord tissue. Table I shows the series from Ewe 5, in which the disease was produced through 16 generations. Table II shows the series from Lamb 29-14. Table III shows the series in which pigs were inoculated from Ewe 5. Details of the

animals inoculated from Ewe 5 and Lamb 29-14 are given in Appendices I and II.

Details of certain inoculations in which negative results were obtained from two other natural cases, Lamb 29-7 and Ewe 4, are shown in Appendix III. These negative results are of little value because only one susceptible animal was inoculated intracerebrally in each case.

TABLE I.

INOCULATIONS FROM EWE 5, IN WHICH POSITIVE RESULTS WERE OBTAINED.

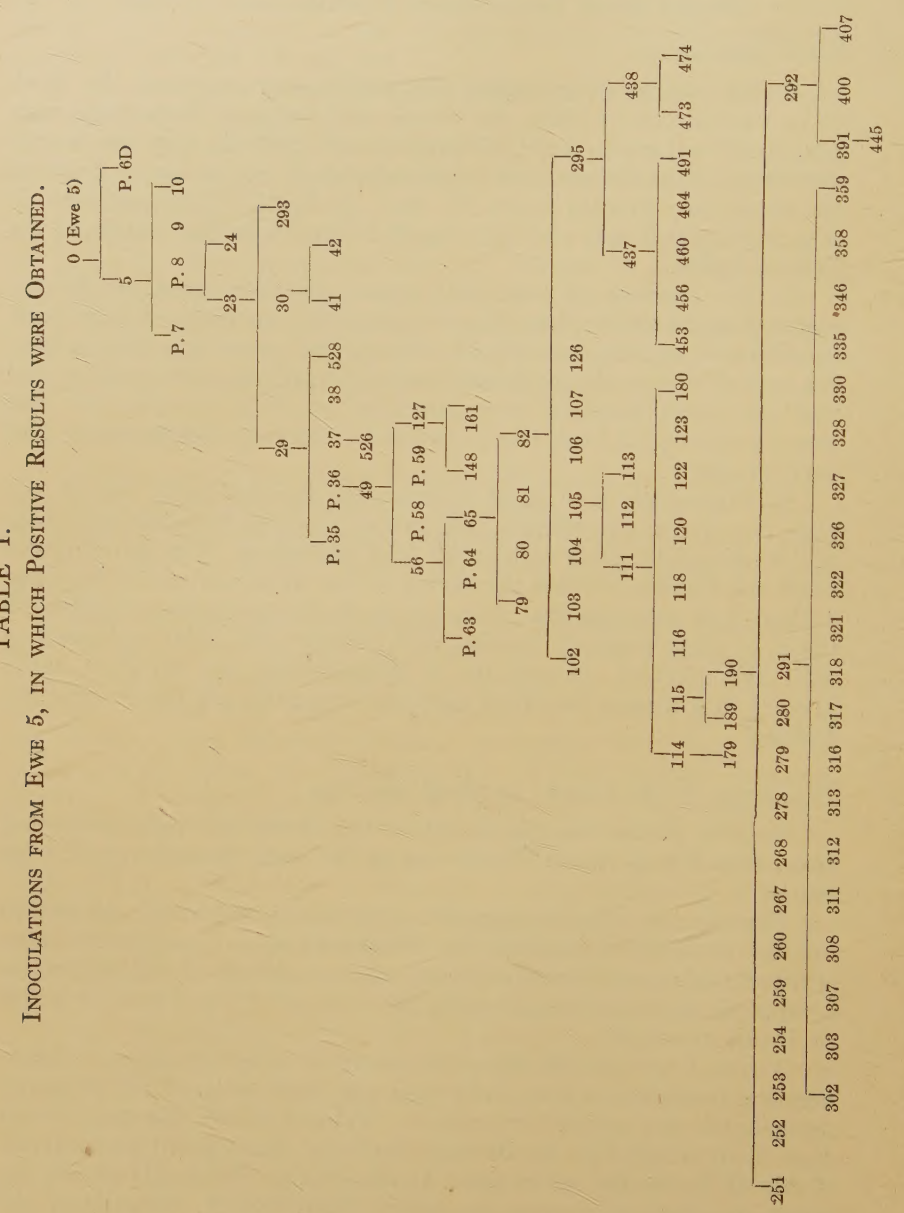


TABLE II.

INOCULATIONS FROM LAMB 29-14.

The numbers of animals which became affected are in **black** type.

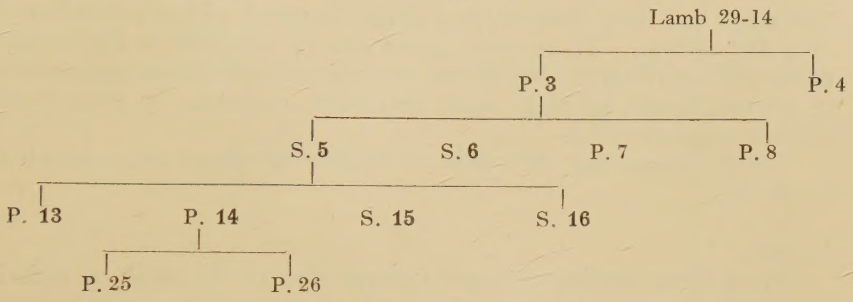
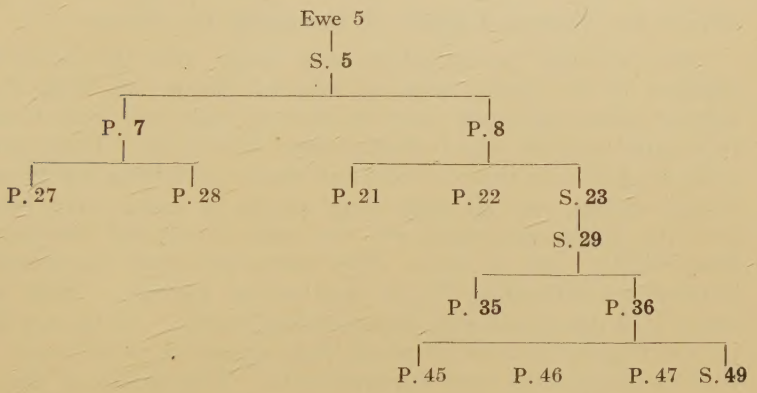


TABLE III.

PIGS INOCULATED IN THE SERIES FROM EWE 5.

The numbers of animals which became affected are in **black** type.



Symptoms.

In both the pigs and the sheep there was a period of incubation of a day or two, followed by a temperature reaction ; otherwise the animals apparently remained in perfect health until about the fifth day after inoculation, and then sickened. In the pigs hyperæsthesia was usually shown for the first day or two of illness together with tremors of the head and limbs, and this was followed by paralysis of the fore or hind or both fore and hind legs. They refused all food, and were acutely ill for a week or two and recovered, or died in the course of a few days.

In the sheep the earliest symptom, apart from the rise in temperature, was dullness ; this was followed by inco-ordination of movement and, frequently, by muscular tremors chiefly involving the head, by salivation, and by champing of the jaws. Within a

few hours or a day or two the animals were unable to stand, but were still able to kick vigorously. At this stage of the disease they lay on one side and were quite unable to change their position. If turned on to the other side they usually struggled until they were replaced in their original position. Coma usually set in soon after this stage had been reached, and death followed within a few hours or a day or two. There was a good deal of variation in the length of the different stages of the illness, and animals which were apparently in normal health at night were frequently comatose or even dead the following morning.

Charts illustrating the types of reaction in sheep are appended (p. 261).

Lesions.

Apart from varying degrees of congestion in the brain or spinal cord and their appendages, there were no striking macroscopic lesions in the affected animals. The abdominal and thoracic organs appeared to be normal. No details of the appearance of the central nervous system are given in Appendices I and II, as the remarks made would only be repetition of the occurrence of congestion.

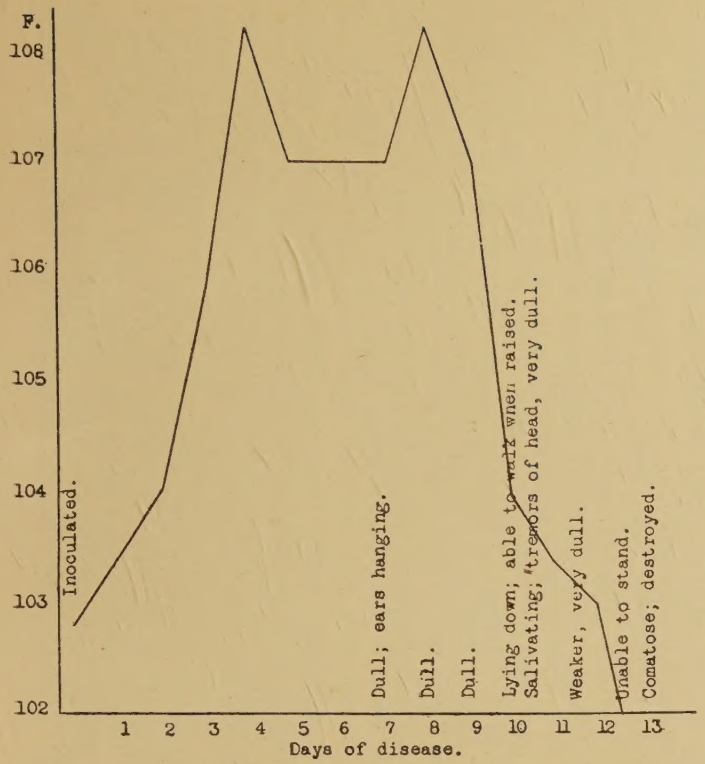
Search for Bacteria Capable of Producing the Disease.

An extensive investigation was made into the occurrence of bacteria in the brain tissue of affected sheep. A large variety of culture tubes was sown from the natural cases and from most of the inoculated animals which died or were destroyed. These comprised ordinary solid and liquid media and media containing sterile unheated sheep's blood. In all cases large pieces of tissue were introduced into the tubes and duplicate sets were incubated ærobically and anærobically, and in some cases extra sets were incubated in an atmosphere containing 10 per cent carbon dioxide. With very few exceptions the inoculated tubes remained sterile. In the few instances in which growths were obtained there appeared to be reason to infer that the organisms were contaminants. The details of the cultural work carried out are not described, as the above general statement appears to give sufficient indication of the stage to which this aspect of the question was taken.

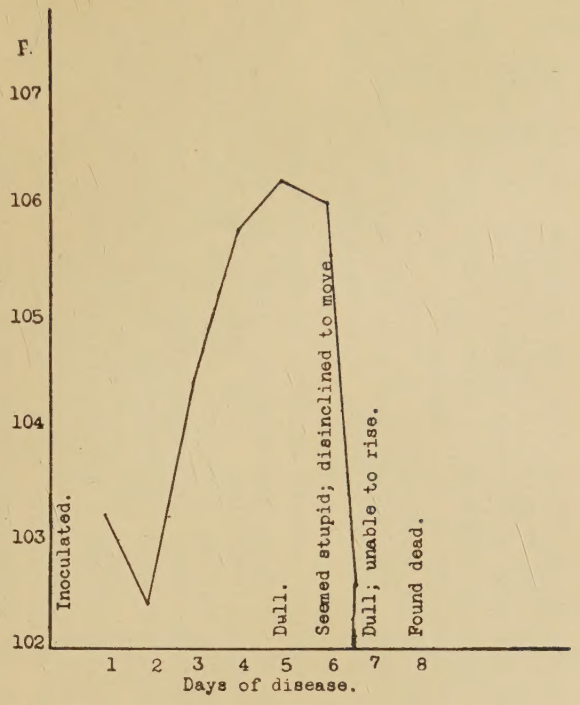
Definition of "Louping-Ill."

The question of the definition of "louping-ill" and of the standards to be used as a basis for its diagnosis are of great importance, but, as yet, little if anything can be added to the remarks of McFadyean and Stockman. And these have already been discussed.

The type of illness produced in the experimental sheep has been described. In judging the results obtained, an animal was only considered to be infected when it died after suffering from an illness characterised by a period of incubation followed by a temperature reaction and symptoms of dys-function of the central nervous system comparable to those mentioned.



SHEEP 82. Inoculated intracerebrally 27.7.29 with brain suspension from Sheep 65.



SHEEP 438. Inoculated intracerebrally 11.9.29 with brain suspension, diluted 1 : 100, from Sheep 295.

A good many of the sheep dealt with showed temperature reactions without other signs of illness. In most cases in which such reactions occurred the rise in temperature was irregular, but in some cases it was exactly similar in period of onset, duration, and severity, to that regarded as typical of the experimental form of " louping-ill."

The extent to which all or some of these reactions were specific to a modified attack of " louping-ill," or were connected with instability of the temperature of sheep, must be left for further consideration. The animals used were hill sheep and lambs kept in unusual circumstances, involving crowding, a great deal of handling, surgical operations, and variations in climatic conditions.

The atypical reactions occurred in sheep submitted to various methods of infection, and were not limited to the sheep subjected to intracerebral inoculation. This indicates that neither suppurative infection nor surgical shock were responsible for the condition.

On the other hand, it is possible that some of the reactions regarded as positive were not really connected with the operation of a specific disease factor. The great constancy with which the disease was reproduced in certain of the experiments is evidence that at least the majority of the cases regarded as positive were directly related to the existence of an infective agent ; moreover, " virus " was demonstrated in the central nervous system of many of them.

In assessing the results of the different experiments reported, the occurrence of temperature reactions without the development of symptoms was regarded as failure to become infected with " louping-ill." This course may lead to error, but it appears to be necessary at present, and in this report no attempt is made to estimate the significance of these reactions.

While there have been cases in which there has been doubt about the result obtained, there have been sufficient cases in which the results have been definitely positive or negative for these alone to be used when forming conclusions.

It may here be noted that a good many of the sheep came from " louping-ill " farms. From the fact that it is unsafe to place sheep from " clean " land on " affected " farms, it is obvious that the native stock of " affected " land possess a degree of immunity to the disease. In the circumstances it was to be expected that a proportion of the animals used in these experiments would show immunity. In the course of the work now reported conclusions were only drawn from negative reactions when they had been repeated with sufficient frequency to indicate that failure to react was beyond a mere coincidence. Eighty-two sheep were inoculated in pairs intracerebrally with brain tissue from affected animals ; 66 of them contracted the disease, and 16 of them remained healthy. In each case failure to contract the disease in this particular set of experiments must be attributed to the possession of immunity, as the material used was always infective. This indicates that, within the scope of the figures available, about 20 per cent. of the inoculated sheep were immune. When definitely infective material was introduced by a definitely infective

route it was rarely found that both of the animals failed to react, although quite frequently one sheep reacted and the other remained healthy.

The use of such sheep may be expected to operate in two directions. They may be expected to possess a higher degree of immunity as compared with sheep from " clean " farms, or, on the other hand, it might be suggested that sheep from " affected " land may carry a latent form of the " virus " in some part of their bodies, and that the diminished resistance following the inoculations carried out may have allowed such a latent " virus " to cause a crisis resulting in an acute attack of the disease.

Modification of the " Virus."

Passage Through Pigs.—Quite early in the course of the work an interesting observation was made on the effect of " passage " from pig to pig. On no less than five occasions when two or more pigs were inoculated from pigs, the disease failed to develop although sheep similarly inoculated from the same pigs contracted the disease (Tables II and III). This has been repeated with sufficient frequency for the inference to be drawn that passage through pigs appears to modify the " virus " to the extent that it cannot be passed from pig to pig.

Passage Through Sheep.—It is likely that passage through the series of sheep modified the state of the " virus," possibly in the direction of increasing its virulence. If this is the case, the results of the work carried out after the completion of the first few passages will be quite different from similar work carried out with fresh " virus " from natural cases. If an invertebrate vector is responsible for the incidence of the disease in natural circumstances, direct inoculation, especially by such a severe method as intracerebral inoculation, will be likely to have caused profound alterations in the state of the " virus." The period of incubation appeared to be shorter in the later series of experiments than in the earlier ones.

Modification of the " virus " may explain the failure of previous investigators to produce the disease. While a natural " virus " will presumably usually infect susceptible sheep when it is introduced by intracerebral inoculation, it may only infect by intravenous or subcutaneous inoculation in a very small proportion of instances, whereas the " passage virus " may usually infect.

Proof that Animals Remain Healthy when Suspensions of Sterile Body Tissue are Properly Introduced by Intracerebral Inoculation.

The employment of intracerebral inoculation should not really require defence. As, however, relatively few pathologists have need to employ the method, and may therefore be doubtful as to its safety, particularly in larger animals, some comment is made on the question.

If absence of a virus capable of causing infection be admitted as absence of virus, the inoculations into rabbits, guinea-pigs, rats, mice, pigeons, fowls, and geese provide evidence that intracerebral

inoculation with suspensions of certain sterile body tissues is well borne.

The failure to infect pigs with pig virus while they could be infected with sheep virus is proof that the procedure fails in itself to cause noticeable disease.

In the case of the sheep, the inoculations with brain suspension diluted beyond 1 : 1,000, blood on certain occasions, cerebro-spinal fluid, and suspensions submitted to the action of chemicals, are sufficient evidence that where specific illness was constantly reproduced it was caused by a factor unrelated to the inoculation procedure. A further and more convincing proof was supplied by the first filtration experiment which yielded negative results because the brain suspension used did not contain " virus." In this experiment 18 sheep inoculated with filtrate and the two controls inoculated with 1 c.c. of standard suspension remained healthy. This was a very severe test of the method and of the particular technique employed.

Experiments Carried Out with Material from Ewe 5.

The Distribution of the " Infective Agent " in the Bodies of Affected Sheep.

The experiments carried out to ascertain the location of the " infective agent " consisted of the intracerebral inoculation of sheep with a suspension of the tissue concerned, or with the actual liquid in the case of cerebro-spinal fluid, aqueous humour, and blood.

In all cases the disease was produced in control sheep by intracerebral inoculation with a suspension of the brain or spinal cord of the sheep from which the test material was obtained.

Brain.—All the inoculations from 110 onwards (shown in Table I) were carried out with brain material alone, and there is ample evidence that it was constantly infective.

Spinal Cord.—S. 145 inoculated with cervical cord probably became affected, and S. 116 and S. 148, inoculated respectively with lumbar and dorsal cord, became affected.

Cerebro-Spinal Fluid.—S. 117, S. 151, and S. 152 remained healthy.

Sciatic Nerve.—S. 302 became affected, and S. 303 probably became affected.

Aqueous Humour.—S. 155 remained healthy.

Blood—The Presence of the " Virus " in the Blood During the Course of the Disease.

The blood of seven sheep was tested. One of them, however, (S. 392) remained healthy. It was, of course, necessary in each case to carry out the inoculations with the blood of the sheep selected for this experiment in anticipation that it would contract the disease.

S. 438 showed a typical temperature reaction, and died on the eighth day, after showing typical symptoms. Sheep were inoculated with blood taken on the second, third, fourth, fifth, sixth, seventh, and eighth days of illness, and all of them remained healthy (S. 452, S. 454, S. 455, S. 457, S. 459, S. 463, S. 471, and S. 472). It therefore appears to be almost certain that " virus " was absent from the blood of S. 438 throughout the illness. Its brain was infective to S. 473.

In the following account of the results of inoculating sheep with blood taken on the different days following inoculation data concerning the animals inoculated from 392 and 438 are omitted.

2nd Day Blood.—S. 451 remained healthy.

3rd Day Blood.—S. 453 became affected.

4th Day Blood.—S. 456 became affected.

5th Day Blood.—S. 431 probably died from other causes. S. 458 probably became affected.

6th Day Blood.—S. 445 and S. 460 became affected.

7th Day Blood.—S. 118, S. 326, S. 327 and S. 464 became affected. S. 325 remained healthy.

9th Day Blood.—S. 158 remained healthy.

Lymphatic Glands.

Popliteal Lymphatic Gland.—S. 161, S. 307, and S. 308 became affected.

Mesenteric Lymphatic Glands.—S. 164 remained healthy ; S. 311, S. 312, and S. 313 became infected.

Bone Marrow.—S. 119 and S. 167 remained healthy.

Spleen.—S. 17 remained healthy. S. 120, S. 316, S. 317 and S. 318 became affected.

Liver.—S. 173 remained healthy.

Skin.—S. 121 remained healthy.

Voluntary Muscle.—The animals from which the muscle was obtained were bled to death. No further steps were taken to remove the blood from the muscle. S. 176 remained healthy. S. 321 and S. 322 became affected.

Summary.—" Virus " has been demonstrated in the brain, spinal cord, sciatic nerve, blood (third, fourth, sixth and seventh days after inoculation), spleen, voluntary muscle, and popliteal and mesenteric lymphatic glands. It is constantly present in the brain. It was probably absent from the blood of S. 438 throughout the illness. In the experiments carried out there was failure to demonstrate " virus " in cerebro-spinal fluid, aqueous humour, bone marrow, liver, and a scraping from the inner surface of the skin.

By What Methods of Introduction Into the Body Can the Infective Agent Produce the Disease ?

In these experiments, suspensions of brain from affected sheep were used as the inocula.

Intracerebral Inoculation.—Table I shows many sheep infected by this route.

Subdural Inoculation.—S. 122 became affected.

Intraspinal Inoculation.—S. 491 became affected ; S. 492 remained healthy.

Inoculation into the Sciatic Nerve.—S. 67 remained healthy.

Intra-Ocular Inoculation.—S. 134 remained healthy ; S. 328 and S. 330 became affected. There was doubt about S. 329, which was weak when inoculated ; it showed a typical temperature reaction and developed incoordination of the movements of the hind legs on the eleventh day.

Supra-Ocular Instillation.—S. 461 became affected ; S. 462 remained healthy.

Intravenous Inoculation.—S. 123 and S. 346 became affected ; S. 347 probably died from other causes ; S. 135 and S. 348 remained healthy.

Intraperitoneal Inoculation.—S. 124, S. 136, S. 331, S. 332 and S. 333 remained healthy.

Pigs 6A, 6B, 6C and 6E 72, 73, 74, 75 and 76 remained healthy. Pig 6D became affected.

Intradermal Inoculation.—S. 138, S. 337, S. 338 and S. 339 remained healthy.

Endermic Inoculation.—S. 139, S. 340, S. 341 and S. 342 remained healthy.

Administration per os.—S. 142, S. 352, S. 353 and S. 354 remained healthy.

Subcutaneous Inoculation.—S. 125, S. 140, S. 334 and S. 336 remained healthy; S. 335 became affected.

Intranasal Instillation.—S. 141, S. 349, S. 350 and S. 351 remained healthy.

Summary.—Infection has been produced by intracerebral, subdural, intra-spinal, intra-ocular, intravenous, and subcutaneous inoculation, and by supra-ocular instillation. In the experiments carried out there was failure to infect by intradermal and endermic inoculation, by inoculation into the sciatic nerve, by administration *per os*, and by intranasal instillation. Intraperitoneal inoculation yielded negative results five times in sheep and nine times in pigs, and yielded a positive result once in a pig.

Can Sheep Become Infected from Contact with Affected Sheep?

Three experiments were carried out.

The first experiment was a failure because the two inoculated sheep placed in contact with the healthy sheep failed to contract the disease. This result was due to an unfortunate choice of material for the preparation of the inoculum. It was obtained from S. 123, in which the illness was rather prolonged and " virus " had probably disappeared from the brain tissue at the time of death.

In the second experiment six healthy sheep (S. 393, S. 394, S. 395, S. 396, S. 397 and S. 398) were penned in close contact with two inoculated sheep (S. 291 and S. 292) immediately the inoculations were carried out. After about a week, when the grass within the penned area became insufficient to support the sheep, they were allowed to mix with other inoculated sheep in a paddock about three acres in extent. Throughout the period of observation there were over fifty inoculated sheep in the paddock every day, and the sheep were in all stages of the infection, fresh inoculated sheep being placed in the paddock to about the same extent as room was made by sheep dying or being discontinued.

Contact was the more intimate from the fact that all the sheep were gathered every morning for the purpose of close observation and temperature recording. The sheep remained healthy for four weeks, during which they were kept under close observation.

In the third experiment, seven healthy sheep (S. 465, S. 466, S. 467, S. 468, S. 469, S. 470 and S. 470A) were placed in the above paddock at a later date. They remained healthy for 19 days during which they were kept under close observation.

The Minimum Dilution at which Intracerebral Inoculation of 1 c.c. of a " Standard " Suspension of Infective Brain will Infect Sheep.

Two separate experiments were carried out. In each case eight sheep were inoculated intracerebrally, and each sheep received 1 c.c. of the suspension diluted to 1 : 10 to 1 : 100,000,000 respectively.

First Experiment.—The sheep receiving the 1 : 10 dilution (S. 188) must definitely have been immune. The sheep receiving the 1 : 100 and 1 : 1,000 dilutions (S. 189 and S. 190) became affected. The sheep receiving the dilutions of 1 : 10,000, 1 : 100,000, and 1 : 1,000,000 remained healthy. The sheep which received the dilutions of 1 : 10,000,000 (S. 194) and 1 : 100,000,000 (S. 195) died.

The temperature reaction of S. 194 was not quite typical, and symptoms were only observed shortly before death. Death may have been due to " louping-ill." There was no temperature reaction in S. 195, and no symptoms were observed during life. Death was probably due to other causes.

Second Experiment.—The sheep which received the dilutions of 1 : 10 and 1 : 100 (S. 437 and S. 438) contracted the disease. S. 439, S. 440, S. 441, S. 442 and S. 444 (1 : 1,000, 1 : 10,000, 1 : 100,000, 1 : 1,000,000 and 1 : 100,000,000) remained healthy. S. 443 (1 : 10,000,000) undoubtedly died from other causes.

Summary.—It is quite obvious that the infective agent present in the brain of affected animals will not usually infect sheep when the brain suspension is diluted to any considerable extent. It is probable that in two sets of experiments carried out infection was only produced with dilutions of 1 : 1,000 or lower.

The Capacity of the " Infective Agent " to Pass Through Bacterial Filters.

Tests were made with Berkefeld N, Chamberland L3, Seitz and Doulton filters. Filtrates and control suspensions were inoculated intracerebrally.

The first experiment carried out was a failure because the control sheep inoculated with the unfiltered material remained healthy.

In the experiments described below controls contracted the disease when inoculated with the material from which the filtrates were prepared. The filtered material was in each case a " standard suspension " of the brain of an affected animal, the suspension being diluted 1 : 20 in order to provide a relatively large volume.

The Berkefeld, Chamberland, and Doulton filters were tested in each case, after soaking and before sterilisation, by pumping air into them, while under water, at a pressure of ten pounds per square inch. The candles were new or were used for the second time only.

A suspension of an 18-hours-old surface agar culture of *B. prodigiosus* was mixed with the brain suspension before filtration, and the filtrates were sown in large amounts into culture media. In all the tests reported the candles had held back the bacilli, but in two tests which have been omitted from this report a Seitz and a Doulton filtrate gave growths of *B. prodigiosus*.

Berkefeld Filter.—S. 368 and S. 370 remained healthy. S. 369 showed a typical temperature reaction, which subsided by the eighth day and was followed by a second quite typical reaction. The animal was dull on the thirteenth day, and found dead on the fifteenth day. If death was due to " louping-ill " it was quite atypical.

Controls.—S. 391 became affected ; S. 392 remained healthy.

Chamberland L3 Filters.

Candle No. I.—S. 371 remained healthy.

Candle No. II.—S. 373, S. 374 and S. 375 remained healthy.

Candle No. III.—S. 376 and S. 377 remained healthy. S. 378 showed a typical temperature reaction, but no symptoms for some days. It became ill on the twelfth day, and was found dead on the thirteenth day.

Controls.—As for Berkefeld filtrate (*supra*).

Doulton Filter.—S. 388, S. 389 and S. 390 remained healthy.

Controls.—As for Berkefeld filtrate (*supra*).

Seitz Filter.—S. 382, S. 383 and S. 384 remained healthy.

Controls.—As for Berkefeld filtrate (*supra*).

Summary.—" Virus " may have passed through the Berkefeld filtrate and infected S. 269, but from the atypical form of the illness this appears to be unlikely. Similarly, the infection may have passed through Chamberland L3, candle No. III. It was not possible to carry out subinoculations from S. 369 and S. 378 at the time.

The Resistance of the Virus.

Viability in 50 Per Cent Glycerol.

Twelve sheep have been inoculated intracerebrally from pieces of brain from eight different artificially infected sheep. The instances in which inoculated animals remained healthy need not here be discussed. Sheep inoculated with brain preserved for 1, 8, 11, 31, 33, 74, 76 and 82 days contracted the disease (S. 179, S. 180, S. 126, S. 295, S. 127, S. 293, S. 526 and S. 528).

Resistance to Chemical Agents Other than Glycerol.

In each case the final concentration was prepared by mixing one volume of " standard suspension " with one volume of a solution of the chemical at double the concentration required. In the case of 5 per cent. phenol the double strength concentration was not, of course, in solution. 1 c.c. amounts were inoculated intracerebrally after standing for three hours at 20° C., except where otherwise stated.

Resistance to Phenol.

Tests carried out showed that intracerebral inoculation of 1 c.c. of suspension containing 5 per cent. phenol was injurious to the brain of a sheep.

2·5 *Per Cent. Phenol.*—S. 249 and S. 250 remained healthy.

1 *Per Cent. Phenol.*—S. 251 and S. 252 became affected.

0·5 *Per Cent. Phenol.*—S. 253 and S. 254 became affected.

Resistance to Formol.

Tests carried out showed that intracerebral inoculation of 1 c.c. of suspension containing 1 per cent. or more of formol was injurious to the brain of a sheep.

0·5 *Per Cent. Formol.*—S. 258 remained healthy.

0·1 *Per Cent. Formol.*—S. 259 became affected.

0·01 *Per Cent. Formol.*—S. 260 became affected.

The Time Taken for 0·01 *Per Cent. Formol to Kill the Infective Agent.*

The suspension of affected brain selected for this experiment was kept in the cold store in the dark at 3° to 6° C.

Two sheep were inoculated with brain exposed for each of the different intervals tested.

Exposure for 3 *Hours.*—S. 399 showed an irregular temperature reaction, and remained healthy until the twelfth day, when it was dull. It was dull on the thirteenth day, and died on the fifteenth day; death was possibly due to other causes. S. 400 became affected.

Exposure for 6 *Hours.*—S. 403 died on the eighth day without showing symptoms. The temperature was 106·4° F. on the first day, and fell gradually to 104·4° F. on the seventh day, with the exception of a rise to 106·6° F. on the sixth day. Death was possibly due to other causes.

S. 404 showed a staggering gait and salivation on the third day, and was found dead on the morning of the fourth day. The temperature was 107° F. on the first day, missed on the second day, and 104·8° F. on the third day. If death was due to "louping-ill" the illness was atypical.

Exposure for 18 *Hours.*—S. 407 probably became affected. S. 408 remained healthy.

Exposure for 24 *Hours.*—S. 411 and S. 412 remained healthy.

Exposure for 48 *Hours.*—S. 415 and S. 416 remained healthy.

The Time Taken for 0·1 *Per Cent. Formol to Kill the Infective Agent.*

S. 401 (3 hours), S. 405 and S. 406 (6 hours), S. 409 and S. 410 (18 hours), S. 413 and S. 414 (23 hours), S. 417 and S. 418 (48 hours), and S. 430 (96 hours) remained healthy.

S. 402 (3 hours) died on the fifteenth day without showing either a temperature reaction or symptoms of illness. Death was probably due to causes unrelated to "louping-ill."

S. 429 (96 hours) had a temperature of 106·4° F. on the fourth day, and 106° F. on the fifth day. It was found dead on the sixth day without having shown any symptoms.

Resistance to Sodium Hydrate.

Tests carried out showed that 1 c.c. of brain suspension containing 0·5 per cent. or more of sodium hydrate was injurious to the brain of a sheep when inoculated by the intracerebral route.

0·05 *Per Cent. Sodium Hydrate.*—S. 266 remained healthy.

0·005 *Per Cent. Sodium Hydrate.*—S. 267 and S. 268 became affected.

Copper Sulphate.

Tests carried out showed that 1 c.c. of suspension containing more than 0·01 per cent. of copper sulphate was injurious to the brain of a sheep when inoculated intracerebrally.

0·01 *Per Cent. Copper Sulphate.*—S. 275 and S. 276 remained healthy.

0·001 *Per Cent. Copper Sulphate.*—S. 277 and S. 278 became affected.

Resistance to Heat.

The experiments were all carried out on the same day. The brain suspension was sealed in amounts of about 2 c.c. in Pasteur pipettes which were immersed for the required interval in a water bath regulated at the required temperature, and rapidly cooled on removal. The volume of water in the bath was about 2,000 times greater than that of the immersed pipettes, and a thermometer was immersed at the same level as the material in the pipettes. The inoculations were completed in all cases within 20 minutes of the removal. No attempt was made to prepare a specially fine

suspension, but it was easily drawn into the capillary part of the ordinary Pasteur pipettes used.

Heat at 60° *C.*

1 *Minute.*—S. 279 and S. 280 became affected.

5 *Minutes.*—S. 281 and S. 282 remained healthy.

15 *Minutes.*—S. 283 and S. 284 failed to contract the disease.

Heat at 80° *C.*

1 *Minute.*—S. 285 and S. 286 remained healthy.

5 *Minutes.*—S. 287 and S. 288 remained healthy.

15 *Minutes.*—S. 289 remained healthy. S. 290 showed a normal temperature until the sixth day. Between the sixth and the tenth days the temperature rose to 106·2° F., and dropped to 104·4° F., rising to 106·2° F. on the eleventh day. The sheep showed no other symptoms of illness until the eleventh day, when it was dull. It remained dull until the fourteenth day, when it died. Death was possibly or probably due to other causes.

Summary.—The " infective agent " is viable in 50 per cent. glycerol for 82 days or longer. It resists exposure for three hours to 0·5 and 1·0 per cent. phenol, and is probably destroyed by such exposure to solutions of 2 per cent. or stronger. It probably resisted exposure to 0·01 per cent. formol for 18 hours, and resisted three hours' exposure to 0·1 per cent. formol in one instance, and was killed in another instance. It was destroyed by such exposure to 0·5 per cent. formol. It resisted three hours' exposure to 0·005 per cent. sodium hydrate, but was possibly destroyed by a concentration of 0·05 per cent. It resisted three hours' exposure to 0·001 per cent copper sulphate, and was possibly destroyed by a concentration of 0·01 per cent.

It resisted exposure to a temperature of 60° C. for one minute, but was destroyed by an exposure of five minutes. It was destroyed by exposure to a temperature of 80° C. for one minute and five minutes, and, presumably, the sheep inoculated with the material heated for 15 minutes died from causes unrelated to " louping-ill."

Attempts to Infect Laboratory Animals with " Louping-Ill."*

All tests consisted of the intracerebral inoculation of brain or brain and spinal cord suspension. In each of the inoculations carried out with material from Lamb 29-14 and from Ewe 5, one or more control sheep, inoculated at the same time and with the same suspension, contracted the disease.

Material from Lamb 29-7. (No infection produced.)

R. 1 and R. 2 remained healthy.

Material from Ewe 4. (No infection produced.)

R. 1 and R. 2 remained healthy.

Material from Lamb 29-14.

R. 1 and R. 2 remained healthy ; *Control* Pig 3.

R. 9 and R. 10, G.P. 11 and G.P. 12 remained healthy ; *Control* S. 5.

Material from Ewe 5.

G.P. 1, G.P. 2, R. 3 and R. 4 remained healthy ; *Control* S. 5.

G.P. 13, R. 15 and R. 16 remained healthy. G.P. 14 died on ninth day,

* In the record of these experiments, R. = rabbit, and G.P. = guinea-pig.

having shown loss of control of limbs from second day ; *Controls* : Pig 7, Pig 8, S. 9 and S. 10.

R. 17, R. 18, G.P. 19 and G.P. 20 remained healthy ; *Controls* : S. 23 and S. 24.

R. 50, R. 51, G.P. 52 and G.P. 53 remained healthy ; *Control* S. 49.

Pigeons 84, 85, 86, 87 and 88 ; Rats 96, 97 and 99 ; and Mice 92, 93 and 94 remained healthy. Pigeon 83 died on ninth day, having been ill since seventh day. Mouse 90 died on 9th day, but had shown no signs of illness during life. *Controls* : S. 79, S. 80, S. 81 and S. 82.

Fowl 108 and Fowl 109 remained healthy ; *Controls* : S. 102, 103, 104 and 105, and Pig 106 and Pig 107.

Goose 178C and 178D remained healthy ; *Control* S. 148.

Summary.—In the experiments carried out to ascertain if animals other than sheep and pigs can be artificially infected, there was no indication that the species tested are highly susceptible. In the odd instances in which infection may have been produced it was not possible to carry out subinoculations.

Discussion.

The introduction of intracerebral inoculation as the main form of routine transmission has yielded the constant results now reported, and this probably accounts for the differences in these experiments when compared with those Stockman described.

An infective agent has been isolated from the central nervous system of two sheep affected with " louping-ill." Cultural and microscopical investigation has failed to demonstrate the presence of a bacterial agent capable of causing the disease. Microscopical examination of tissues has so far failed to disclose the existence of any Protozoan agent in circumstances in which etiological relationship can be suspected. While filtration experiments have given inconclusive results, none of the work carried out has produced evidence against the existence of an ultramicroscopic virus : indeed, the methods by which infection has been produced, the dissemination of the infective material in the bodies of affected animals, and its behaviour when exposed to the action of glycerol and other chemical agents, suggest that " louping-ill " is a " virus disease."

The type of infection, coupled with the circumstantial evidence that in natural circumstances it is transmitted by ticks, suggests the possibility that it may be associated with Rickettsia.

Conclusions.

1. " Louping-ill " has been produced experimentally in sheep and pigs.
2. No evidence was found of the existence of a bacterial agent capable of causing the disease.
3. Infection does not occur from contact.
4. An infective agent is present in certain tissues of affected sheep.
5. At some stage of the disease the infective agent is probably constantly present in the central nervous system of affected sheep ;

it is usually but not constantly present in the mesenteric and popliteal lymphatic glands and spleen. It is usually present in the blood at some stage of the infection, but may be absent throughout the illness. It was not demonstrated in cerebro-spinal fluid, aqueous humour, bone marrow, liver, or skin.

6. Infection has been produced by intracerebral, intraspinal, intrasciatic, intra-ocular, intravenous and subcutaneous inoculation, and by supra-ocular instillation. It was not produced by intramuscular, intradermal, or endermic inoculation, intranasal instillation, or by administration *per os*.

7. Filtration experiments have not been completed. Most of the experiments now reported yielded negative results.

8. The infective agent is viable in 50 per cent. glycerol for at least 82 days. It resisted exposure for three hours at 20° C. to 1 per cent. phenol, 0·005 per cent. sodium hydrate, and 0·001 per cent. copper sulphate. It was destroyed by similar exposure to 0·5 per cent. formol, 0·05 per cent. sodium hydrate, and 0·01 per cent. copper sulphate. It resisted exposure for one minute to a temperature of 60° C., and was destroyed by exposure for five minutes or more.

9. The experiments carried out have not shown that any animals other than sheep or pigs are susceptible to the infection.

APPENDIX I.

Transmission Experiments Carried Out with Material from Ewe 5.

The abbreviations used in this Appendix and elsewhere in this report are shown on p. 289.

The numbers given to the animals refer to the number of the particular experiment with material from Ewe 5. The gaps in the series are due, with few exceptions, to the allocation of numbers to other work carried out in the course of the enquiry, that is, to work not connected with animal experimentation. A fresh series of numbers was started for the experiments carried out with material from each of the natural cases of "louping-ill" so studied. (*Vide* Appendices II and III.)

Unless otherwise stated, the transmission experiments consisted of intracerebral inoculations with suspensions prepared from brain tissue alone or mixed brain and spinal cord tissue.

In all the inoculations carried out down to 109 a suspension of mixed brain and spinal cord was used. As soon as the "infective agent" was found to be constantly present in the brain this tissue alone was used in order to simplify technique and to reduce labour.

The term "healthy" is used in the restricted sense of freedom from signs of illness detectable by visual observation and without any reference to the body temperature. Temperatures were recorded at irregular intervals in the experiments prior to 79. They were recorded once daily in the morning for 10-20 days in the case of the remainder of the series.

G.P. 1.—May 30th, 1929. From Ewe 5. R.H.

G.P. 2.—May 30th, 1929. From Ewe 5. Died June 9th, 1929. No symptoms during life.

R. 3.—May 30th, 1929. From Ewe 5. R.H.

R. 4.—May 30th, 1929. From Ewe 5. R.H.

S. 5.—May 30th, 1929. From Ewe 5. H. until eighth day, when was dull; lying down; able to stand, but fell down if driven. T. 104·7° F. Destroyed by bleeding.

S. 6.—May 30th, 1929. From Ewe 5. Found dead on ninth morning. At autopsy the brain showed evidence of trauma at operation. No symptoms were observed during life.

Pig 6A.—May 30th, 1929. ip. from Ewe 5. R.H. This animal had previously been inoculated as Pig 3 of 29-7.

Pig 6B.—May 30th, 1929. ip. from Ewe 5. R.H. This animal had previously been inoculated as Pig 4 of 29-7.

Pig 6C.—May 30th, 1929. ip. from Ewe 5. R.H. This animal had previously been inoculated as Pig 4 of 29-14.

Pig 6D.—May 30th, 1929. ip. from Ewe 5. This animal had previously been inoculated as Pig 3 of Ewe 4. H. until May 12th, 1929 (13 days after inoculation from Ewe 5 and 25 days after inoculation from Ewe 4), when became affected; recovered after severe paralytic illness.

Pig 6E.—May 30th, 1929. ip. from Ewe 5. R.H. This animal had previously been inoculated as Pig 4 of Ewe 4.

Pig 6F.—May 30th, 1929. ip. from Ewe 5. R.H. This animal had previously been inoculated as Pig 4 of Ewe 4.

Pig 7.—June, 7th, 1929. From Pig 5. H. until sixth day, when only able to stand with difficulty. Attempted to eat. T. 103·4° F. On seventh day able to rise on front legs, but very little strength in hind legs; trembling; T. 100° F. On eighth day still able to use forelegs; trembling; able to struggle to trough and feed. T. 101° F. On ninth day progressed by leaping movements, but unable to stand properly. T. 101·2° F. On tenth day able to stand with difficulty; moving better, though awkwardly. Killed on eleventh day, as brain required for inoculation of other animals.

Pig 8.—June 7th, 1929. From Pig 5. On sixth day T. 103·5° F. Appeared to be in pain occasionally. On seventh day unable to stand; able to move on fore legs, but not on hind legs; trembling. T. 101·6° F. Destroyed on seventh day.

S. 9.—June 7th, 1929. From Pig 5. H. until seventh day, when found to be turning towards left side; trembling. T. 105° F. By afternoon unable to stand. Found dead on the morning of eighth day.

S. 10.—June 7th, 1929. From Pig 5. Found dead on morning of fifth day. No symptoms observed during life.

S. 11.—June 7th, 1929. (Filtrate) from Pig 5. R.H.

G.P. 13.—June 7th, 1929. From Pig 5. R.H.

G.P. 14.—June 7th, 1929. From Pig 5. Showed loss of muscular control on second day, remained in this condition on the subsequent days, and died on ninth day.

R. 15.—June 7th, 1929. From Pig 5. R.H.

R. 16.—June 7th, 1929. From Pig 5. R.H.

R. 17.—June 14th, 1929. From Pig 8. R.H.

R. 18.—June 14th, 1929. From Pig 8. R.H.

G.P. 19.—June 14th, 1929. From Pig 8. R.H.

G.P. 20.—June 14th, 1929. From Pig 8. R.H.

Pig 21.—June 14th, 1929. From Pig 8. R.H.

Pig 22.—June 14th, 1929. From Pig 8. R.H.

S. 23.—June 14th, 1929. From Pig 8. H. until eighth day, when was dull. On ninth morning comatose. Destroyed.

S. 24.—June 14th, 1929. From Pig 8. H. until sixth day, when was dull. On seventh day dullness more pronounced ; lips twitching ; salivating. On eighth day still able to stand ; shaking head and unable to keep it steady for long ; lips twitching ; champing jaws. Died same evening.

Pig 27.—June 18th, 1929. From Pig 7. R.H.

Pig 28.—June 18th, 1929. From Pig 7. R.H.

S. 29.—June 24th, 1929. From S. 23. H. until sixth day, when there was staggering gait and some muscular inco-ordination ; twitching of lower lip. T. 105° F. ; destroyed.

S. 30.—June 24th, 1929. From S. 23. H. until seventh day, when there was some dullness and muscular inco-ordination. Later in day was lying down and unable to rise ; profuse salivation ; lips twitching ; champing jaws ; trembling ; T. 105·5° F. On eighth day comatose ; T. 100·5° F. Destroyed.

Pig 35.—June 30th, 1929. From S. 29. H. until fifth day, when there was muscular inco-ordination ; great difficulty in rising and, later, inability to move without falling down ; trembling. T. 104·2° F. Sent to Weybridge.

Pig 36.—June 30th, 1929. From S. 29. H. until fifth day, when was excitable and unable to lie quietly ; trembling ; when disturbed there was opisthotonos. T. 103·1° F. ; destroyed.

S. 37.—June 30th, 1929. From S. 29. H. until sixth day, when was unable to rise, and lay kicking ; salivating ; died same day.

S. 38.—June 30th, 1929. From S. 29. H. until sixth day, when was found dead in morning.

S. 41.—July 2nd, 1929. From S. 30. H. until seventh day, when was found dead in morning.

S. 42.—July 2nd, 1929. From S. 30. T. typical ; H. until sixth day, when was dull ; staggering gait ; found dead on morning of seventh day.

Pig 45.—July 5th, 1929. From Pig 36. Sent to Weybridge. R.H.

Pig 46.—July 5th, 1929. From Pig 36. Sent to Weybridge. R.H.

Pig 47.—July 5th, 1929. From Pig 36. R.H.

S. 48.—July 5th, 1929. From Pig 36. R.H.

S. 49.—July 5th, 1929. From Pig 36. H. until seventh day, when was dull ; shaking head and salivating ; showed staggering gait when moved ; T. 105·2° F. ; died in afternoon.

R. 50.—July 5th, 1929. From Pig 36. R.H.

R. 51.—July 5th, 1929. From Pig 36. R.H.

G.P. 52.—July 5th, 1929. From Pig 36. R.H.

G.P. 53.—July 5th, 1929. From Pig 36. R.H.

S. 56.—July 12th, 1929. From S. 49. H. until sixth day, when was dull, and standing with head hanging down and salivating. T. 105·4° F. On seventh day dullness increased ; could only walk with difficulty, and staggered and fell occasionally. T. 104·8° F. Destroyed.

Pig 58.—July 12th, 1929. From S. 49. H. until seventh day, when was rather slow in rising from ground, and showed slight muscular inco-ordination. T. 105° F. On eighth day unable to rise ; trembling ; T. 105·2° F. On ninth day able to stand with difficulty when raised, but soon fell down. Tried to eat when put at trough, but this produced spasms in dorsal and cervical muscles. Thereafter animal gradually recovered, and was normal in about a week.

Pig 59.—July 12th, 1929. From S. 49. H. until ninth day, when legs were partially paralysed ; T. 103·9° F. On tenth day lay kicking all day ; trembling. After a few days there was improvement, and animal

eventually recovered after very serious illness and great loss in condition.

S. 60.—July 12th, 1929. isc. from S. 49. Found dead on morning of ninth day. Death probably due to infestation with liver flukes.

Pig 63.—July 19th, 1929. From S. 56. H. until seventh day, when showed paralysis of fore limbs ; unable to keep neck straight ; trembling and excited. T. 106·1° F. This condition persisted during two following days ; then improvement set in, and pig was apparently normal by 13th day.

Pig 64.—July 19th, 1929. From S. 56. H. until seventh day, when was excitable. T. 104·4° F. On eighth day trembling and staggering. T. 103° F. On ninth day unable to rise, and suffered from attacks of convulsions. T. 101° F. Condition worse during following days, but by the thirteenth day, although there was great emaciation, pig began to take liquid food, and finally recovered.

S. 65.—July 19th, 1929. From S. 56. H. until seventh day, when was dull ; T. 106·3° F. On following day unable to rise ; destroyed.

S. 66.—July 19th, 1929. From S. 56. R.H.

S. 67.—July 19th, 1929. isc. from S. 56. R.H.

Pig 72.—July 12th, 1929. ip. from S. 49. R.H.

Pig 73.—July 12th, 1929. ip. from S. 49. (This animal had previously been inoculated as Pig 25 of Lamb 29-14.) R.H.

Pig 74.—July 12th, 1929. ip. from S. 49. (This animal had previously been inoculated as Pig 26 of Lamb 29-14.) R.H.

Pig 75.—July 12th, 1929. ip. from S. 49. (This animal had previously been inoculated as Pig 27 [supra].) R.H.

Pig 76.—July 12th, 1929. ip. from S. 49. (This animal had previously been inoculated as Pig 28 [supra].) R.H.

S. 79.—July 27th, 1929. From S. 65. T. typical. H. until sixth day, when was dull, staggering and trembling. Killed when comatose on following day.

S. 80.—July 27th, 1929. From S. 65. T. typical ; H. until seventh day, when was staggering ; died same day.

S. 81.—July 27th, 1929. From S. 65. T. typical. H. until seventh day, when there was paralysis of the fore legs ; moved on knees ; very dull ; died following day. There was a small area of suppuration at the site of inoculation.

S. 82.—July 27th, 1929. From S. 65. T. typical. H. until evening of fifth day, when there was very slight tremor of head. This was more pronounced next day, and animal was staggering, and fell down at times ; destroyed in evening.

Pn. 83.—July 27th, 1929. From S. 65. H. until seventh day, when was dull ; wings drooping slightly ; dull on eighth day ; found dead on ninth day.

Pn. 84.—July 27th, 1929. From S. 65. R.H.

Pn. 85.—July 27th, 1929. From S. 65. R.H.

Pn. 86.—July 27th, 1929. From S. 65. R.H.

Pn. 87.—July 27th, 1929. From S. 65. R.H.

Pn. 88.—July 27th, 1929. From S. 65. R.H.

M. 90.—July 27th, 1929. From S. 65. H. until seventh day, when was found dead.

M. 92.—July 27th, 1929. From S. 65. R.H.

M. 93.—July 27th, 1929. From S. 65. R.H.

M. 94.—July 27th, 1929. From S. 65. R.H.

Rat 95.—July 27th, 1929. From S. 65. R.H.
Rat 96.—July 27th, 1929. From S. 65. R.H.
Rat 97.—July 27th, 1929. From S. 65. R.H.
Rat 98.—July 27th, 1929. From S. 65. R.H.
Rat 99.—July 27th, 1929. From S. 65. R.H.
S. 102.—August 2nd, 1929. From S. 82. T. typical. H. until fifth day, when lips were twitching and was salivating; on sixth day salivation more pronounced; staggering. Died on seventh day.
S. 103.—August 2nd, 1929. From S. 82. Sent to Weybridge. Developed the disease.
S. 104.—August 2nd, 1929. From S. 82. Sent to Weybridge. Developed the disease.
S. 105.—August 2nd, 1929. From S. 82. T. typical. H. until 5th day, when was staggering; unable to stand on sixth day; destroyed.
Pig 106.—August 2nd, 1929. From S. 82. Sent to Weybridge. Developed the disease.
Pig 107.—August 2nd, 1929. From S. 82. Sent to Weybridge. Developed the disease.
F. 108.—August 2nd, 1929. From S. 82. R.H.
F. 109.—August 2nd, 1929. From S. 82. R.H.
S. 111.—August 8th, 1929. From S. 105. T. typical. H. until fourth day, when was slightly dull. Appeared to be brighter on fifth day; unable to stand on sixth day; destroyed.
S. 112.—August 8th, 1929. With l.C. sn. from S. 105. T. typical. H. until sixth day, when was dull; dull on seventh day; on eighth day unable to rise, and lying with poll held back to dorsal region; destroyed.
S. 113.—August 8th, 1929. With l.C. sn. from S. 105. T. typical; H. until sixth day, when was dull; dull on seventh day. By afternoon of eighth day unable to rise, and kicking violently; destroyed.
S. 114.—August 14th, 1929. From S. 111. T. typical; H. until seventh day, when was unable to rise, and kicking violently; destroyed.
S. 115.—August 14th, 1929. From S. 111. T. typical; H. until seventh day, when was dull. Ears were hanging downwards and backwards. Condition same on eighth day; on morning of ninth day was semi-comatose and kicking occasionally; destroyed.
S. 116.—August 14th, 1929. With l.C. sn. from S. 111. T. typical; H. until fifth day, when was staggering slightly. Condition same on sixth day. On morning of seventh day unable to rise; lying quietly; destroyed.
S. 117.—August 14th, 1929. With 1 c.c. c.s.f. from S. 111. R.H.
S. 118.—August 14th, 1929. With 1 c.c. citrated blood from S. 111. T. typical; H. until seventh day, when was dull, and ears were hanging downwards and backwards. Condition same on eighth day. On ninth day trembling violently and staggering, and had very little control over muscles of near fore leg. Died same day.
S. 119.—August 14th, 1929. With bone marrow sn. from S. 111. R.H.
S. 120.—August 14th, 1929. With spleen sn. from S. 111. T. typical; H. until eighth day, when was unable to rise, lying stretched out, kicking involuntarily, and showing tremors of head. Found dead on morning of ninth day.
S. 121.—August 14th, 1929. With sn. from scraping of under surface of skin (prepared with precautions as to sterility) from S. 111. R.H. after showing an atypical T. reaction.
S. 122.—August 14th, 1929. sd. from S. 111. T. typical. H. until fifth

day, when was dull ; unable to rise for a time on seventh day, but walked unsteadily later ; tremor of head. Found dead on morning of eighth day.

S. 123.—August 14th, 1929. iv. from S. 111. T. reaction typical, with the exception that it was prolonged. From fourth to tenth days T. was 107° F. or over, and thereafter dropped to 102·8° F. on twelfth day. H. until seventh day, when was dull, with ears hanging downwards and backwards. Condition same on eighth and ninth days. On tenth day lying down, but could walk when raised and helped. Salivating slightly ; tremors of head. On eleventh day noted to be gradually becoming weaker ; unable to stand on twelfth day ; destroyed.

S. 124.—August 14th, 1929. ip. from S. 111. Showed typical but rather prolonged T. reaction—106°-107° F. from fourth to tenth days ; R.H.

S. 125.—August 14th, 1929. sc. from S. 111. T. typical ; R.H.

S. 126.—August 14th, 1929. With brain from S. 82 kept eleven days in 50 per cent. glycerol. T. typical ; H. until eighth day, when was dull and staggering slightly. Found dead on morning of ninth day.

S. 127.—August 14th, 1929. With brain from S. 49 kept 33 days in 50 per cent. glycerol ; T. typical ; H. until eighth day, when was unable to rise ; occasional convulsions ; marked trembling, especially of head ; destroyed.

S. 128.—August 14th, 1929. From S. 24 with sn. kept 54 days in 50 per cent. glycerol. R.H.

S. 134.—August 22nd, 1929. is. from S. 127. R.H.

S. 135.—August 22nd, 1929. iv. from S. 127. R.H.

S. 136.—August 22nd, 1929. ip. from S. 127. Atypical T. reaction. R.H.

S. 137.—August 22nd, 1929. im. from S. 127. R.H.

S. 138.—August 22nd, 1929. id. from S. 127. R.H.

S. 139.—August 22nd, 1929. ed. from S. 127. Typical. R.H.

S. 140.—August 22nd, 1929. sc. from S. 127. T. typical. R.H.

S. 141.—August 22nd, 1929. in. from S. 127. T. typical. R.H.

S. 142.—August 22nd, 1929. po. from S. 127. T. typical. R.H.

S. 145.—August 22nd, 1929. With c.C. sn. from S. 127. T. typical. No symptoms noted during life. Found dead on morning of seventh day.

S. 148.—August 22nd, 1929. With d.C. sn. from S. 127. T. typical ; unable to rise on morning of seventh day. Found dead on morning of eighth day.

S. 151.—August 22nd, 1929. With c.s.f. from S. 127. R.H.

S. 152.—August 22nd, 1929. With c.s.f. from S. 127. R.H.

S. 155.—August 22nd, 1929. With aqueous humour from S. 127. R.H.

S. 158.—August 22nd, 1929. With blood from S. 127. R.H.

S. 161.—August 22nd, 1929. With p.l.gl. sn. from S. 127. T. typical ; H. until eighth day, when was staggering in morning and unable to stand in evening. Condition same on ninth and tenth days. Found dead on morning of eleventh day.

S. 164.—August 22nd, 1929. With m.l.gl. sn. from S. 127. T. typical. R.H.

S. 167.—August 22nd, 1929. With bone marrow sn. from S. 127. R.H.

S. 170. August 22nd, 1929. With spleen sn. from S. 127. R.H.

S. 173.—August 22nd, 1929. With liver sn. from S. 127. R.H.

S. 176.—August 22nd, 1929. With voluntary muscle sn. from S. 127. R.H.

S. 178A.—August 22nd, 1929. iv. with m.l.gl. sn. from S. 127. R.H.

S. 178B.—August 22nd, 1929. sc. with m.l.gl. from S. 127. R.H.
G. 178C.—August 22nd, 1929. ic. from S. 127. R.H.
G. 178D.—August 22nd, 1929. iv. from S. 127. R.H.
S. 179.—August 22nd, 1929. From S. 114. With sn. kept one day in 50 per cent. glycerol. T. typical ; H. until sixth day, when was holding head slightly to left ; staggering and salivating. Later in day fell down when attempting to walk, and died later.
S. 180.—August 22nd, 1929. From S. 111 with sn. kept eight days in 50 per cent. glycerol. T. typical ; H. until seventh day, when was unable to stand, and lay with poll drawn to back. Died on morning of eighth day.
S. 183.—August 22nd, 1929. From S. 65 with sn. kept 27 days in 50 per cent. glycerol ; T. typical ; H. until seventh day, when was dull and weak, but able to walk when placed on feet ; found dead on morning of eighth day.
S. 188.—August 23rd, 1929. From S. 115 with sn. diluted 1 : 10. R.H.
S. 189.—August 23rd, 1929. From S. 115 with sn. diluted 1 : 100. T. typical ; H. until sixth day, when was staggering ; unable to stand, and kicking at intervals on seventh day ; died later.
S. 190.—August 22nd, 1929. From S. 115 with sn. diluted 1 : 1,000 ; T. typical ; H. until seventh day, when was unable to stand ; very excited ; trembling ; destroyed.
S. 191.—August 23rd, 1929. From S. 115 with sn. diluted 1 : 10,000. R.H.
S. 192.—August 23rd, 1929. From S. 115 with sn. diluted 1 : 100,000. R.H.
S. 193.—August 23rd, 1929. From S. 115 with sn. diluted 1 : 1,000,000. R.H.
S. 194.—August 23rd, 1929. From S. 115 with sn. diluted 1 : 10,000,000. T. fairly typical ; H. until sixth day, when was unable to stand, and died in evening. Observers doubtful if should be considered a case in which infection had been set up.
S. 195.—August 23rd, 1929. From S. 115 with sn. diluted 1 : 100,000,000. No. T. reaction. H. until morning of sixth day, when was seen to fall ; died an hour later. No lesion found at P.M. to account for death. Death probably due to other causes.
S. 249.—August 30th, 1929. From S. 190 with sn. exposed for three hours to 2·5 per cent. phenol. R.H.
S. 250.—August 30th, 1929. From S. 190 with sn. exposed for three hours to 2·5 per cent. phenol. R.H.
S. 251.—August 30th, 1929. From S. 190 with sn. exposed for three hours to 1 per cent. phenol. T. typical. H. until sixth day, when was dull ; staggering and falling on seventh day ; comatose eighth day ; found dead later.
S. 252.—August 30th, 1929. From S. 190 with sn. exposed for three hours to 1 per cent. phenol. T. typical ; H. until seventh day, when was unable to rise. Found dead on morning of eighth day.
S. 253.—August 30th, 1929. From S. 190 with sn. exposed for three hours to 0·5 per cent. phenol. T. typical ; H. until fifth day, when was dull ; unable to rise on morning of sixth day, and died that night.
S. 254.—August 30th, 1929. From S. 190 with sn. exposed for three hours to 0·5 per cent. phenol. T. typical ; H. until sixth day, when was dull, and walked with unsteady gait ; found dead on morning of seventh day.
S. 258.—August 30th, 1929. From S. 190 with sn. exposed for three hours to 0·5 per cent. formol. R.H.

S. 259.—August 30th, 1929. From S. 190 with sn. exposed for three hours to 0·1 per cent. formol. T. typical; H. until fifth day, when gait was uncertain; apparently normal on sixth day; dull on seventh day; comatose on eighth day; found dead on morning of ninth day.

S. 260.—August 30th, 1929. From S. 190 with sn. exposed for three hours to 0·01 per cent. formol; T. fairly typical; H. until sixth day, when unable to rise; found dead on morning of seventh day.

S. 266.—August 30th, 1929. From S. 190 with sn. exposed for three hours to 0·05 per cent. NaOH. R.H.

S. 267.—August 30th, 1929. From S. 190 with sn. exposed for three hours to 0·005 per cent. NaOH. T. typical; H. until sixth day, when was unable to rise; on seventh day unable to rise, and salivating; found dead on morning of eighth day.

S. 268.—August 30th, 1929. From S. 190 with sn. exposed for three hours to 0·005 per cent. NaOH. T. typical; H. until fifth day, when gait was uncertain. Condition same on sixth day; unable to rise on morning of seventh day, and died that afternoon.

S. 275.—August 30th, 1929. From S. 190 with sn. exposed for three hours to 0·01 per cent. copper sulphate. R.H.

S. 276.—August 30th, 1929. From S. 190 with sn. exposed for three hours to 0·01 per cent. copper sulphate. R.H.

S. 277.—August 30th, 1929. From S. 190 with sn. exposed for three hours to 0·001 per cent. copper sulphate. H. until ninth day, when was staggering; found dead on tenth day.

S. 278.—August 30th, 1929. From S. 190 with sn. exposed for three hours to 0·001 per cent. copper sulphate. T. reaction fairly typical; H. until sixth day, when was unable to rise; on seventh day condition same; died on morning of eighth day.

S. 279.—August 30th, 1929. From S. 190 with sn. heated at 60° C. for one minute. T. typical; H. until seventh day, when was dull and unwilling to walk; found dead on morning of eighth day.

S. 280.—August 30th, 1929. From S. 190 with sn. heated at 60° C. for one minute. T. typical; H. until sixth day, when was dull; seventh day, scarcely able to walk; eighth day, dull, but still able to stand and walk; condition same on ninth day; found dead on morning of tenth day.

S. 281.—August 30th, 1929. From S. 190 with sn. heated at 60° C. for five minutes. T. was 106° F. on first day, and remained high till eleventh day. No symptoms were shown. The high temperature without usual period of incubation suggests that it was unconnected with development of "virus." It is assumed that the heating destroyed "infective agent."

S. 282.—August 30th, 1929. From S. 190 with sn. heated at 60° C. for five minutes. R.H.

S. 283.—August 30th, 1929. From S. 190 with sn. heated at 60° C. for 15 minutes. T. 105·2° F. on fourth and fifth days, and rose to 105·8° to 106° on 11th, 12th and 13th days. It had not the curve of infected animals. Sheep observed to be shaking on morning of fifth day, but thereafter normal. There does not appear to be reason to infer that it became infected with "louping-ill."

S. 284.—August 30th, 1929. From S. 190 with sn. heated at 60° C. for 15 minutes. T. 104·8° F. on first day, and rose 1 degree, and remained there from 6th to 13th days. Sheep remained otherwise in perfect health. There does not appear to be reason to infer that it became infected with "louping-ill."

S. 285.—August 30th, 1929. From S. 190 with sn. heated at 80° C. for one minute. T. reaction would be classified as typical until seventh day, when after returning to normal it showed a further reaction lasting four days. Sheep remained otherwise in perfect health.

S. 286.—August 30th, 1929. From S. 190 with sn. heated at 80° C. for one minute. T. 106° F. on sixth day, and fluctuated between 105° and 107·4° from 7th to 14th days, showing regular rise and fall. Sheep remained otherwise in perfect health.

S. 287.—August 30th, 1929. From S. 190 with sn. heated at 80° C. for five minutes. T. normal, except for sudden rise to 106·4° F. on eleventh day, and return to normal on following day. Sheep remained otherwise in perfect health.

S. 288.—August 30th, 1929. From S. 190 with sn. heated at 80° C. for five minutes. T. normal for first seven days with exception of rise to 105·8° F. (from 104·2° F.) on fifth day. Rose to 106·5° F. on eighth day, and remained above 105° F. until twelfth day. Sheep otherwise in perfect health.

S. 289.—August 30th, 1929. From S. 190 with sn. heated at 80° C. for 15 minutes. T. typical. R.H.

S. 290.—August 30th, 1929. From S. 190 with sn. heated at 80° C. for 15 minutes. T. normal until sixth day, but between sixth and tenth days rose to 106·2° F., and dropped to 104·4° F., rising to 106·2° F. on eleventh day. Sheep showed no symptoms of illness until eleventh day, when was dull; remained dull until fourteenth day, when died. Death possibly or probably due to other causes.

S. 291.—August 30th, 1929. From S. 190. T. fairly typical; H. until sixth day, when was unable to stand in morning and destroyed.

S. 292.—August 30th, 1929. From S. 190. T. typical; H. until sixth day, when was staggering. Unable to rise, and salivating on seventh day; destroyed.

S. 293.—September 4th, 1929. With sn. from S. 24 kept 74 days in 50 per cent. glycerol. T. typical; H. until sixth day, when was dull; found dead on morning of seventh day.

S. 295.—September 4th, 1929. With sn. from S. 82, kept for 31 days in 50 per cent. glycerol. T. reaction not quite typical; T. reached 107·4° F. on third day; sheep dull on third day; unable to stand on fifth day; unable to rise on sixth day, and destroyed on seventh day. S. 437 and 438 inoculated with sn. from its brain contracted typical attacks of inoculation disease.

S. 302.—September 5th, 1929. With sn. from sciatic nerve of S. 291. T. typical; H. until seventh day, when was unable to rise; lips twitching; found dead on morning of eighth day.

S. 303.—September 5th, 1929. With sn. from sciatic nerve of S. 291; T. rose to 106° F. on first day, but otherwise typical; this early rise in temperature discounts value of observations on this sheep; H. until fifth day, when was salivating and unable to rise; died during afternoon.

S. 307.—September 5th, 1929. With sn. of p.l.gl. of S. 291. T. typical; H. until third day, when was dull; on fourth day only able to rise with difficulty, and disinclined to move; unable to rise on fifth day; found dead on morning of seventh day.

S. 308.—September 5th, 1929. With sn. from p.l.gl. of S. 291; T. rose to 105·8° F. on first day; otherwise typical; H. until sixth day, when was dull and disinclined to move; found dead on morning of seventh day.

S. 311.—September 5th, 1929. With sn. from m.l.gl. from S. 291; T.

typical ; H. until seventh day, when was dull ; found dead on morning of eighth day.

S. 312.—September 5th, 1929 With sn from m.l.gl. from S. 291 ; T. typical ; H. until sixth day, when was unable to rise ; comatose on seventh day ; died during the day.

S. 313.—September 5th, 1929. With sn. from m.l.gl. from S. 291 ; T. probably typical, but missed on third day. H. until fourth day, when was dull ; very dull on fifth day ; found dead on morning of sixth day.

S. 316.—September 5th, 1929. With sn. of spleen from S. 291. T. probably typical, but missed on fourth and sixth days ; H. until fourth day, when was very dull and disinclined to move ; on fifth day dull, and could only rise with difficulty ; condition same on sixth day ; comatose on seventh and eighth days ; died on afternoon of ninth day.

S. 317.—September 5th, 1929. With sn. of spleen from S. 291. T. typical ; H. until sixth day, when was dull, and walked with uncertain gait, and was disinclined to move ; comatose on seventh and eighth days ; found dead on morning of ninth day.

S. 318.—September 5th, 1929. With sn. of spleen from S. 291 ; T. typical except that after returning to normal just before onset of symptoms (which was usual) ; T. rose from 104·2° F. on sixth day to 107° F. on seventh day, and then dropped ; H. until sixth day, when gait was uncertain, and there was tendency to move towards the left ; comatose on seventh day ; found dead on morning of eighth day.

S. 321.—September 5th, 1929. With sn. of voluntary muscle from S. 291. T. typical ; H. until eighth day, when was unable to rise ; died at noon.

S. 322.—September 5th, 1929. With sn. of voluntary muscle from S. 291. T. typical ; H. until seventh day, when was unable to rise, and lips were twitching ; unable to rise, and lips twitching on eighth day ; found dead on morning of ninth day.

S. 325.—September 5th, 1929. With blood from S. 291. R.H.

S. 326.—September 5th, 1929. With blood from S. 291. T. typical ; H. until seventh day, when was disinclined to move, and when lying down could only rise with difficulty ; comatose on eighth day ; found dead on morning of ninth day.

S. 327.—September 5th, 1929. With blood from S. 291. T. typical ; H. until eighth day, when was comatose ; found dead on morning of ninth day.

S. 328.—September 5th, 1929. io. from S. 291 ; T. typical ; H. until seventh day, when was dull ; unable to rise on eighth day, and died same afternoon.

S. 329.—September 5th, 1929. io. from S. 291 ; T. fairly typical until seventh day, and thereafter normal. Sheep dull on sixth day, but apparently normal on eighth, ninth and tenth days ; showed staggering gait and dullness from tenth day onwards, but condition may have been due to weakness. Observations discontinued on 15th day. Doubtful if became affected.

S. 330.—September 5th, 1929. io. from S. 291. T. typical ; H. until tenth day, when was dull and stupid, and carried nose at an unnaturally high position ; dull, stupid and staggering on eleventh day ; found dead on morning of twelfth day.

S. 331.—September 5th, 1929. ip. from S. 291 ; R.H.

S. 332.—September 5th, 1929. ip. from S. 291 ; R.H.

S. 333.—September 5th, 1929. ip. from S. 291 ; R.H.

S. 334.—September 5th, 1929. sc. from S. 291 ; T. typical ; R.H.

S. 335.—September 5th, 1929. sc. from S. 291 ; T. typical till fifth day, when had returned to normal ; then rose to 105·4° F. on sixth day, and to 106° F. on seventh day. Sheep showed no symptoms until eighth day, when unable to rise, and lay on side, kicking occasionally ; found dead on morning of ninth day ; doubtful if sheep became affected.

S. 336.—September 5th, 1929. sc. from S. 291 ; R.H.

S. 337.—September 5th, 1929. id. from S. 291 ; T. 105·4° F. on first day, and rose gradually to 106·8° F. on seventh day, and dropped to 104·2° F. on eleventh day. No symptoms. T. reaction quite different from that of an animal suffering from an illness with an incubation period, and probably due to causes unrelated to the inoculation.

S. 338.—September 5th, 1929. id. from S. 291 ; some T. reaction to 105·8° F. on third day. T. missed on fourth day, and normal on fifth day. R.H.

S. 339.—September 5th, 1929. id. from S. 291 ; R.H.

S. 340.—September 5th, 1929. ed. from S. 291 ; R.H.

S. 341.—September 5th, 1929. ed. from S. 291 ; R.H.

S. 342.—September 5th, 1929. ed. from S. 291 ; R.H.

S. 343.—September 5th, 1929. ed. from S. 291 ; R.H.

S. 344.—September 5th, 1929. im. from S. 291 ; T. 106° F. on first day, and remained at that height until fifth day, and dropped to 104·4° F. T. unrelated to the inoculation. R.H.

S. 345.—September 5th, 1929. im. from S. 291 ; R.H.

S. 346.—September 5th, 1929. iv. from S. 291. T. 105·6° F. on first day ; 106·4° F. on second day, missed on third day, and 106·4° F. on fourth day ; 105° F. on fifth day ; 105·8° F. on sixth day ; 106·2° F. on seventh day. H. until seventh day, when was unable to rise, and lay on side, kicking occasionally ; died on afternoon of same day.

S. 347.—September 5th, 1929. iv. from S. 291 ; T. atypical—106° F. on second day, dropping to 104·8° F. on fifth day ; then showed fairly typical curve of the acute type of reaction from fifth to eighth days (seen earlier in typical cases). H. until eleventh day, when was unable to rise. Remained in this condition on twelfth and thirteenth days ; found dead on morning of fourteenth day.

S. 348.—September 5th, 1929. iv. from S. 291 ; R.H.

S. 349.—September 5th, 1929. in. from S. 291 ; R.H.

S. 350.—September 5th, 1929. in. from S. 291 ; some T. reaction, but not typical ; R.H.

S. 351.—September 5th, 1929. in. from S. 291 ; R.H.

S. 352.—September 5th, 1929. po. from S. 291 ; R.H.

S. 353.—September 5th, 1929. po. from S. 291 ; R.H.

S. 354.—September 5th, 1929. po. from S. 291 ; R.H.

S. 355 (*S.* 66).—September 5th, 1929. ic. from S. 291 ; atypical T. reaction ; R.H. Had failed to react to ic. inoculation from S. 56 on July 19th, 1929. May have been naturally immune, or have acquired immunity from first inoculation.

S. 356 (*S.* 67).—September 5th, 1929. From S. 291 ; atypical T. reaction ; R.H. Had failed to react to isc. inoculation from S. 56 on July 19th, 1929. May have been naturally immune or have acquired immunity from first inoculation.

S. 357 (*S.* 117).—September 5th, 1929. From S. 291. Had failed to react to inoculation of c.s.f. from S. 111 on August 14th, 1929. May have

been naturally immune, or may have acquired immunity from first inoculation.

S. 358 (*S.* 119).—September 5th, 1929. From S. 291 ; T. typical. H. until sixth day, when there was difficulty in rising, and head was held low ; unable to rise on seventh day ; comatose on eighth day ; died that afternoon. This sheep had failed to react to ic. inoculation of bone marrow from S. 111 on August 14th, 1929.

S. 359 (*S.* 121).—September 5th, 1929. From S. 291 ; T. not quite typical, but was 107° F. on fifth day ; H. until sixth day, when was dull, and showing some paralysis of hind quarters, walking with staggering gait ; unable to rise on seventh day, and showing spasmodic contractions of fore legs ; head held with poll close to withers ; found dead on morning of eighth day. Had been inoculated on August 14th, 1929. ic. with skin scraping from S. 111, and had remained healthy after showing atypical T. reaction.

S. 360 (*S.* 124).—September 5th, 1929. From S. 291 ; R.H. Had been inoculated on August 14th, 1929. ic. from S. 111, and had shown a typical but prolonged T. reaction, but otherwise R.H.

S. 361 (*S.* 128).—September 5th, 1929. From S. 291 ; R.H. Had been inoculated with sn. kept 54 days in 50 per cent. glycerol, from S. 24, and had R.H.

S. 368.—September 6th, 1929. With filtrate (Berkefeld) from S. 292 ; R.H.

S. 369.—September 6th, 1929. With filtrate (Berkefeld) from S. 292. T. typical till seventh day, when dropped to normal ; a further reaction similar to a typical one of first few days followed between eighth and thirteenth days. Animal showed no other symptoms until twelfth days, when was disinclined to move, and stood with head hanging down. Found dead on morning of thirteenth day. If illness due to " louping-ill," was quite atypical.

S. 370.—September 6th, 1929. With filtrate (Berkefeld) from S. 292. R.H.

S. 371.—September 6th, 1929. With filtrate (Chamberland L3) from S. 292. R.H.

S. 373.—September 6th, 1929. With filtrate (Chamberland L3) from S. 292. R.H.

S. 374.—September 6th, 1929. With filtrate (Chamberland L3) from S. 292. R.H.

S. 375.—September 6th, 1929. With filtrate (Chamberland L3) from S. 292. T. typical ; R.H.

S. 376.—September 6th, 1929. With filtrate (Chamberland L3) from S. 292. T. rose 1·6° F. on third, fourth and fifth days ; R.H.

S. 377.—September 6th, 1929. With filtrate (Chamberland L3) from S. 292. T. fairly typical ; R.H.

S. 378.—September 6th, 1929. With filtrate (Chamberland L3) from S. 292. T. typical. H. until twelfth day, when was unable to rise ; found dead on morning of thirteenth day. No inoculations carried out with material from this animal.

S. 379.—September 6th, 1929. With filtrate (Chamberland L3) from S. 292. R.H.

S. 380.—September 6th, 1929. With filtrate (Seitz) from S. 292. R.H.

S. 382.—September 6th, 1929. With filtrate (Seitz) from S. 292. T. typical. R.H.

S. 383.—September 6th, 1929. With filtrate (Seitz) from S. 292. R.H.

S. 384.—September 6th, 1929. With filtrate (Seitz) from S. 292. R.H.

S. 388.—September 6th, 1929. With filtrate (Doulton) from S. 292. Irregular T. reaction between third and tenth days ; R.H.

S. 389.—September 6th, 1929. With filtrate (Doulton) from S. 292. R.H.

S. 390.—September 6th, 1929. With filtrate (Doulton) from S. 292. R.H.

S. 391.—September 6th, 1929. With B.sn. from S. 292. T. typical ; H. until sixth day, when was dull ; dull on seventh and eighth days ; found dead on morning of ninth day.

S. 392.—September 6th, 1929. From S. 292. R.H.

S. 393.—September 6th, 1929. Placed in contact with S. 291 and S. 392. Observed closely for four weeks ; T. 106·2° F. on fifth and sixth days, and 107·6° F. on ninth day ; R.H.

S. 394.—September 6th, 1929. Placed in contact with S. 391 and S. 392. Observed closely for four weeks. T. 106·4° F. on tenth day ; R.H.

S. 395.—September 6th, 1929. Placed in contact with S. 391 and S. 392. Observed closely for four weeks. R.H.

S. 396.—September 6th, 1929. Placed in contact with S. 391 and S. 392. Observed closely for four weeks. R.H.

S. 397.—September 6th, 1929. A weak sheep. Placed in contact with S. 391 and S. 392. Kept under close observation for four weeks. Remained as healthy as at commencement of experiment.

S. 398.—September 6th, 1929. A weak sheep. Placed in contact with S. 391 and S. 392. Kept under close observation for four weeks. Remained as healthy as at commencement of experiment.

S. 399.—September 6th, 1929. With sn. from S. 292 exposed for three hours to 0·01 per cent. formol. Irregular T. reaction ; H. until twelfth day, when was dull ; dull on thirteenth day ; found dead on morning of fourteenth day ; death possibly due to causes unconnected with " louping-ill."

S. 400.—September 6th, 1929. With sn. from S. 292 exposed for three hours to 0·01 per cent. formol. T. typical until sixth day, when, instead of dropping to normal, rose to 107·2° F. from 104·2° F. ; H. until seventh day, when was unable to rise ; comatose on eighth day ; found dead on morning of ninth day.

S. 401.—September 6th, 1929. With sn. from S. 292 exposed for three hours to 0·1 per cent. formol ; R.H.

S. 402.—September 6th, 1929. With sn. from S. 292 exposed for three hours to 0·1 per cent. formol ; died on fifteenth day ; having shown no symptoms, it had been discontinued from close observation on tenth day. Death probably due to causes unconnected with " louping-ill."

S. 403.—September 6th, 1929. With sn. from S. 292 exposed for six hours to 0·01 per cent. formol. T. 106·4° F. on first day, gradually falling to 104·4° F. on seventh day, with the exception of a rise to 106·6° F. on sixth day ; found dead on morning of eighth day, never having shown any symptoms. Death possibly due to causes unconnected with " louping-ill."

S. 404.—September 6th, 1929. With sn. from S. 292 exposed for six hours to 0·01 per cent. formol. T. 107° F. on first day ; missed on second day ; 104·8° F. on third day ; staggering and salivating on third day ; found dead on morning of fourth day. If death was due to " louping-ill," the illness, from type of T. reaction and early onset of symptoms, was atypical.

S. 405.—September 6th, 1929. With sn. from S. 292 exposed for six hours to 0·1 per cent. formol. R.H.

S. 406.—September 6th, 1929. With sn. from S. 292 exposed for six hours to 0·1 per cent. formol. R.H.

S. 407.—September 6th, 1929. With sn. from S. 292 exposed for 18 hours to 0·01 per cent. formol. T. not quite typical, but not very atypical; H. until eighth day, when was dull; dull on ninth day; comatose on morning of tenth day; died same evening. Death probably due to "louping-ill."

S. 408.—September 7th, 1929. With sn. from S. 292 exposed for 18 hours to 0·01 per cent. formol; R.H.

S. 409.—September 7th, 1929. With sn. from S. 292 exposed for 18 hours to 0·1 per cent. formol; R.H.

S. 410.—September 7th, 1929. With sn. from S. 292 exposed for 18 hours to 0·1 per cent. formol. T. normal until sixth day; 107° F. on seventh day, and 106° F. on eighth day; normal thereafter; R.H.

S. 411.—September 7th, 1929. With sn. from S. 292 exposed for 23 hours to 0·1 per cent. formol; T. typical till fifth day, and normal thereafter; R.H.

S. 412.—September 7th, 1929. With sn. from S. 292 exposed for 23 hours to 0·01 per cent. formol; T. irregular; R.H.

S. 413.—September 7th, 1929. With sn. from S. 292 exposed for 23 hours to 0·1 per cent. formol; R.H.

S. 414.—September 7th, 1929. With sn. from S. 292 exposed for 23 hours to 0·1 per cent. formol; R.H.

S. 415.—September 7th, 1929. With sn. from S. 292 exposed for 48 hours to 0·01 per cent. formol; T. normal, with the exception of 106° F. on sixth day; R.H.

S. 416.—September 8th, 1929. With sn. from S. 292 exposed for 48 hours to 0·01 per cent. formol; R.H.

S. 417.—September 8th, 1929. With sn. from S. 292 exposed for 48 hours to 0·1 per cent. formol; R.H.

S. 418.—September 8th, 1929. With sn. from S. 292 exposed for 48 hours to 0·1 per cent. formol; R.H.

S. 422.—September 9th, 1929. With 1 c.c. blood (fourth day) from S. 392. T. normal till fourth day, but was 105°-106° F. on fifth, sixth, seventh and eighth days. R.H. S. 392 did not contract the disease.

S. 429.—September 10th, 1929. With sn. from S. 292 exposed for 96 hours to 0·1 per cent. formol. T. 106·4° F. on fourth day and 106° F. on fifth day. Found dead on morning of sixth day without having shown symptoms.

S. 430.—September 10th, 1929. With sn. from S. 292 exposed for 96 hours to 0·1 per cent. formol. T. not atypical; R.H.

S. 431.—September 10th, 1929. With 1 c.c. blood (fifth day) from S. 391. No T. reaction; H. until third day, when was dull; comatose on sixth day, and found dead on morning of seventh day. Illness and death probably due to causes unconnected with "louping-ill."

S. 434.—September 10th, 1929. With 1 c.c. blood (fifth day) from S. 392. R.H. S. 392 did not contract the disease.

S. 437. September 11th, 1929. With sn. from S. 295 diluted 1 : 10; T. typical; H. until fifth day, when was dull; unable to rise on sixth day; destroyed on seventh day.

S. 438.—September 11th, 1929. With sn. from S. 295 diluted 1 : 100; T. typical; H. until fifth day, when was dull; dull on sixth and seventh days, and found dead on eighth day.

S. 439.—September 11th, 1929. With sn. from S. 295 diluted 1 : 1,000. T. typical, but delayed and prolonged, lasting from sixth to tenth days. R.H.

S. 440.—September 11th, 1929. With sn. from S. 295 diluted 1 : 10,000. R.H.

S. 441.—September 11th, 1929. With sn. from S. 295 diluted 1 : 100,000. R.H.

S. 442.—September 11th, 1929. With sn. from S. 295 diluted 1 : 1,000,000. R.H.

S. 443.—September 11th, 1929. With sn. from S. 295 diluted 1 : 10,000,000. Found dead on ninth day. No T. reaction ; never showed symptoms of illness. Death undoubtedly due to causes unconnected with " louping-ill."

S. 444.—September 11th, 1929. With sn. from S. 295 diluted 1 : 100,000,000. R.H.

S. 445.—September 11th, 1929. With 1 c.c. blood (sixth day) from S. 391. T. typical ; H. until fifth day when was disinclined to move ; walked with uncertain gait, and was trembling ; destroyed.

S. 446.—September 11th, 1929. With 1 c.c. blood (sixth day) from S. 392. R.H. S. 392 did not contract the disease.

S. 451.—September 12th, 1929. With 1 c.c. blood (second day) from S. 437. R.H.

S. 452.—September 12th, 1929. With 1 c.c. blood (second day) from S. 438. R.H.

S. 453.—September 13th, 1929. With 1 c.c. blood (third day) from S. 437. T. typical ; H. until sixth day, when at times was walking in circles, and staggering backwards ; on seventh day dull ; able to stand, but disinclined to move ; on eighth day still dull, but movements rather more active than on previous day ; found dead on morning of ninth day.

S. 454.—September 13th, 1929. With 1 c.c. blood (third day) from S. 438. R.H.

S. 455.—September 14th, 1929. With 1 c.c. blood (fourth day) from S. 438. R.H.

S. 456.—September 14th, 1929. With 1 c.c. blood (fourth day) from S. 437. T. typical ; H. until seventh day, when was dull, and disinclined to move ; head nodding ; found dead on morning of eighth day.

S. 457.—September 15th, 1929. With a c.c. blood (fifth day) from S. 438. Sheep appeared to be affected by the inoculation, as it held its head in an unnaturally high position for first three days. R.H.

S. 458.—September 15th, 1929. With 1 c.c. blood (fifth day) from S. 437. T. fairly typical. Found dead on morning of sixth day, without having shown any symptoms of illness. Not possible to form opinion as to whether death occurred from " louping-ill " or not.

S. 459.—September 16th, 1929. With 1 c.c. blood (sixth day) from S. 438. R.H.

S. 460.—September 16th, 1929. With 1 c.c. blood (sixth day) from S. 437. T. typical ; H. until fifth day, when was dull ; on sixth day unable to rise and kicking ; forelegs contracted spasmodically ; lips twitching ; comatose on seventh day ; found dead on morning of eighth day.

S. 461.—September 16th, 1929. so. from S. 445. T. typical, but prolonged, lasting from third to ninth days. H. until tenth day, when was comatose ; died same afternoon.

S. 462.—September 16th, 1929. so. from S. 445. R.H.

S. 463.—September 17th, 1929. With 1 c.c. blood (seventh day) from S. 438. R.H.

S. 464.—September 17th, 1929. With 1 c.c. blood (seventh day) from S. 437. T. typical. H. until seventh day, when was unable to rise ; died same morning.

S. 465.—September 16th, 1929. Contact experiment with several affected sheep in all stages of the disease. Kept under observation for ten days. R.H.

S. 466.—September 16th, 1929. Contact experiment with several affected sheep in all stages of the disease. Kept under observation for ten days. R.H.

S. 467.—September 16th, 1929. Contact experiment with several affected sheep in all stages of the disease. Kept under observation for ten days. R.H.

S. 468.—September 16th, 1929. Contact experiment with several affected sheep in all stages of the disease. Kept under observation for ten days. R.H.

S. 469.—September 16th, 1929. Contact experiment with several affected sheep in all stages of the disease. Kept under observation for ten days. R.H.

S. 470.—September 16th, 1929. Contact experiment with several affected sheep in all stages of the disease. Kept under observation for ten days. R.H.

S. 470A.—September 16th, 1929. Contact experiment with several affected sheep in all stages of the disease. Kept under observation for ten days. R.H.

S. 471.—September 18th, 1929. With 1 c.c. blood (eighth day) from S. 438. R.H.

S. 472.—September 18th, 1929. With 1 c.c. blood (eighth day) from S. 438. R.H.

S. 473.—September 19th, 1929. From S. 438. T. typical ; H. until fourth day, when was dull, and stood with head hanging down and held to right side ; condition same on fifth day ; destroyed.

S. 474.—September 19th, 1929. From S. 438. T. typical ; H. until seventh day, when was comatose ; died in afternoon.

S. 491.—September 18th, 1929. is. from S. 437. T. typical ; H. until sixth day, when hind quarters were paralysed ; condition same on seventh day ; on eighth day could not raise body on fore quarters ; found dead on morning of ninth day.

S. 492.—September 18th, 1929. is. with sn. from S. 437. R.H.

S. 526.—September 20th, 1929. With sn. from S. 37 kept in 50 per cent. glycerol for 76 days. T. typical ; H. until third day, when was dull ; was healthy on fourth and fifth days, and again dull on sixth day ; hind legs paralysed on seventh day ; destroyed.

S. 527.—September 20th, 1929. With sn. from S. 82 kept in 50 per cent. glycerol for 47 days. R.H.

S. 528.—September 20th, 1929. With sn. from S. 29 kept in 50 per cent. glycerol for 82 days. T. typical ; H. until sixth day, when was comatose ; found dead on morning of seventh day.

APPENDIX II.

Transmission Experiments Carried Out with Material from Lamb 29-14.

R. 1.—May 16th, 1929. With 0·3 c.c. B.C.sn.; R.H.

R. 2.—May 16th, 1929. With 0·3 c.c. B.C.sn.; R.H.

Pig 3.—May 16th, 1929. With 0·5 c.c. B.C.sn.; H. until twelfth day, when there was inco-ordination of movement, muscular weakness, and tremor of hind quarters; at times there were vigorous kicking movements with hind limbs; head was held slightly to left, and there was a tendency for the animal to move to this side. On thirteenth day the pig was unable to rise, and was destroyed.

Pig 4.—May 16th, 1929. sc. with 2 c.c. B.C.sn.; R.H.

S. 5.—May 29th, 1929. With 0·75 c.c. B.C.sn. and c.s.f. from Pig 3; H. until seventh day, when was unable to rise; eyes bright; T. 104·2° F. Destroyed.

S. 6.—May 29th, 1929. With 0·75 c.c. B.C.sn. and c.s.f. from Pig 3; H. until eighth day, when was unable to rise; kicking when disturbed; died about midday.

Pig 7.—May 29th, 1929. With 0·75 c.c. B.C.sn. and c.s.f. from Pig 3; R.H.

Pig 8.—May 29th, 1929. With B.C.sn. from Pig 3; R.H.

R. 9.—May 30th, 1929. With 0·2 c.c. B.C.sn. and c.s.f. from Pig 3; R.H.

R. 10.—May 30th, 1929. With 0·3 c.c. B.C.sn. and c.s.f. from Pig 3; R.H.

G.P. 11.—May 30th, 1929. With 0·3 c.c. B.C.sn. and c.s.f. from Pig 3; R.H.

G.P. 12.—May 30th, 1929. With 0·5 c.c. B.C.sn. from Pig 3; R.H.

Pig 13.—May 5th, 1929. With 0·3 c.c. B.C.sn. from S. 5; H. until fifth day, when was dull and occasionally held the head on one side; not feeding. On sixth day not feeding; unable to stand, but able to use hind legs for progression, and moved on knees; very dull, and lay quiet most of the time. T. 105° F.; not feeding; on eighth day unable to stand; trembling; still able to use forelegs properly, but power appeared to be returning to hind legs. On ninth day T. 101·8° F.; rather more power in all four legs; on tenth day able to stand on hind legs; front legs still weak; on eleventh day able to stand on all four legs occasionally; able to take liquid food. Thereafter steadily recovered.

Pig 14.—June 5th, 1929. With B.C.sn. from S. 5; H. until fifth day, when was dull; tended to hold head to right side; on sixth day dull; not feeding; trembling; T. 103·5° F.; on eighth day T. 102·4° F.; not feeding; unable to stand; hind legs weaker than fore legs; on ninth day T. 102·4° F.; unable to stand; any movement threw the animal into general muscular tremors; on tenth day T. 102·8° F.; trembling violently; unable to stand; on eleventh day trembling violently; able to rise, but soon fell; could swallow liquid placed in mouth; on twelfth day tremors less violent; lay quietly if not disturbed; on thirteenth day able to stand; tremors still present; destroyed.

S. 15.—June 5th, 1929. With B.C.sn. from S. 5; H. until sixth day, when was lying down; did not move away when approached; when lifted on to its feet, stood, but trembled violently; when made to walk, staggered, and lay down after going half-a-dozen steps; T. 105·4 F.; eyes bright; destroyed.

S. 16.—June 5th, 1929. With B.C.sn. from S. 5. Died on eighth day without showing any symptoms.

R. 17.—June 5th, 1929. With B.C.sn. from S. 5. R.H.
Pig 25.—June 18th, 1929. With B.C.sn. from Pig 14. R.H.
Pig 26.—June 18th, 1929. With B.C.sn. from Pig 14. R.H.

APPENDIX III.

Instances in which Negative Results were Obtained from Inoculations Carried Out with Suspensions Prepared from Brain and Spinal Cord from Natural Cases of "Louping-Ill."

Lamb 29-7.—Pig 3 was inoculated intracerebrally, and Pig 4 subcutaneously. Both remained healthy. At a later date they were both inoculated intraperitoneally in the Ewe 5 series as Pigs 6A and 6B, and again remained healthy.

Ewe 4.—Pig 3 was inoculated intracerebrally, and Pig 4 and S. 5 and 6 were inoculated subcutaneously. All remained healthy. At a later date, Pigs 3 and 4 were inoculated intraperitoneally in the Ewe 5 series as Pigs 6D and 6E.

Abbreviations.

ic.	= Intracerebral inoculation.	d.	= Dorsal.
sd.	= Subdural inoculation.	l.	= Lumbar.
is.	= Intra-Spinal Inoculation.	sn.	= Suspension.
io.	= Intra-ocular inoculation.	B.sn.	= Brain suspension.
iv.	= Intravenous inoculation.	B.C.sn.	= Brain + spinal cord suspension.
ip.	= Intraperitoneal inoculation.		
im.	= Intramuscular inoculation.	p.	= Pulse.
sc.	= Subcutaneous inoculation.	B.	= Brain.
id.	= Intradermal inoculation.	S.	= Sheep.
ed.	= Endermic inoculation.	R.	= Rabbit.
so.	= Supra-ocular instillation.	G.P.	= Guinea-pig.
in.	= Intra-nasal instillation.	G.	= Goose.
po.	= Per os.	Pn.	= Pigeon.
isc.	= Intra-sciatic inoculation.	F.	= Fowl.
c.s.f.	= Cerebro-spinal fluid.	M.	= Mouse.
m.l.gl.	= Mesenteric lymphatic gland.	H.	= Healthy.
p.l.gl.	= Popliteal lymphatic gland.		
C.	= Cord (spinal).	T.	= Temperature.
c.	= Cervical.	R.H.	= Remained healthy.

"Standard Suspension."—A piece of brain about the size of a walnut was ground up with a pestle and mortar with about 20 grams of sterile silver sand and 60 c.c. of sterile 0·85 per cent. salt solution. The liquid portion of the mixture was pipetted into a sterile test tube, and the supernatant fluid was used for inoculation after the liquid had sedimented for half an hour.

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THE CORPORA AMYLACEA OF THE MAMMARY GLAND OF THE COW.

By Sir John McFadyean.

Notwithstanding abundant opportunities for the study of the so-called amyloid bodies of the mammary gland, opinion still appears to be far from uniform in regard to their structure and composition, and, above all, the cause of their formation. The present author must at the outset disclaim ability to throw much new light on the most obscure points ; his main purpose is by means of micro-photographs to show with more precision than has hitherto been attempted the internal structure of these bodies. In the first place, however, it will be appropriate to give a summary of the more important articles that have already appeared on the same subject.

Ottolenghi's* account of amyloid bodies in the cow's udder occurs in an article on the histology of the active mammary gland. His observations were made on the udder of five newly slaughtered cows, five of which were giving milk, and he could not find any previous mention of these bodies in the literature. The examination was conducted partly on teased preparations of particles of gland tissue in normal saline solution, and partly on sections. He found that the bodies resisted solution in absolute alcohol, ether, chloroform, 1 per cent. acetic acid, 10 per cent. hydrochloric acid, 5 to 10 per cent. sulphuric acid, and 36 per cent. caustic potash. Diluted hydrochloric acid made them somewhat paler, with more delicate contours, but the stratification remained distinct. In the concentrated alkali solution after many hours they became less distinct and appeared somewhat swollen, but the concentric strata remained distinct. Pure sulphuric acid, hydrochloric acid, and strong nitric acid make them first paler and then rather quickly dissolved them. When treated with Lugol's solution they took on a colour between straw-yellow, mahogany-red, and brown-red, and when afterwards treated with pure or 10 per cent. sulphuric acid the colour changed to a yellow-orange tint, but some showed a dark brown-red colour, and a central brown nucleus. When stained with aniline stains the bodies showed the same colour as the corpora amylacea of the prostate—red with methylviolet, gentian violet, iodinegreen, and methylgreen, and orange-red with saffranin. With hæmatxylin and eosin some took the colour of the former and the others the colour of the latter, but it was noticed that the whole of each body was not stained uniformly. The staining affected especially the outer parts, whereas the remainder of the body showed the same colour as the surrounding tissue. It thus appeared that the bodies behaved like the true amyloid substance and the corpora amylacea of the prostate with regard to analine stains, but were differentiated from both of these by staining with iodine and sulphuric acid. The bodies showed distinct concentric stratification and often also a delicate radial striation. They were strongly refractile, and were found free in the alveolar cavity, resting on the epithelium, or within the epithelium cells, or even in the interstitial connective tissue or partly in the latter and partly in an alveolar cavity. When lying in the epithelium the smaller ones appeared to be composed of three or four epithelial cells, but the larger seemed to take the place of the epithelium, or the body was covered with a regular or irregular collection of epithelial cells. In the

* Arch. f. mikr. Amatomie, Bd. 58, 1901, p. 581.

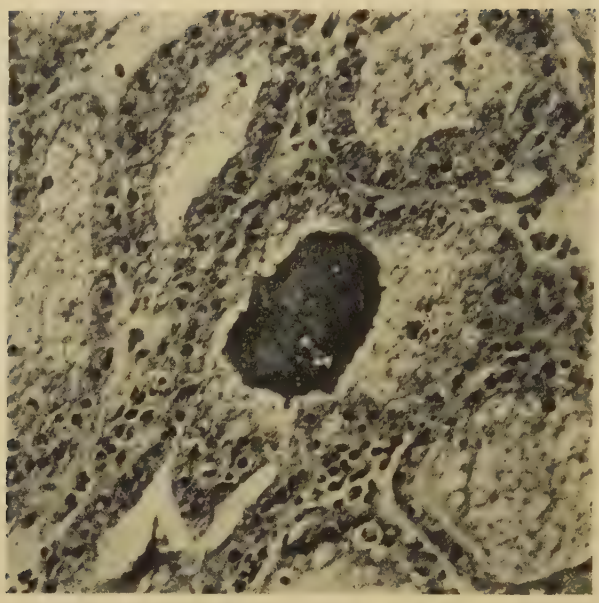

FIG. 1.

The dark body in the centre may represent the central or initial part of an amyloid body. × 275.

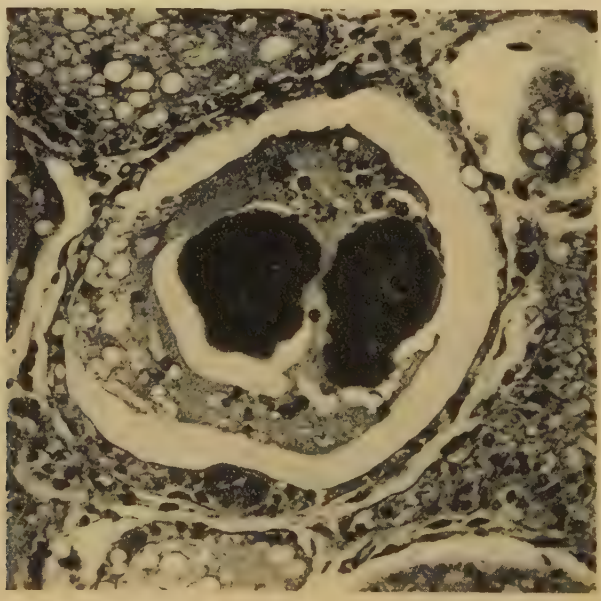

FIG. 2.

The early stage of two independently formed bodies in the contents of an alveolus. At the lower part of the same alveolus a small body is seen embedded in the epithelial lining. × 280.

author's opinion it appeared to be not improbable that all the bodies had their origin in the alveoli, and in nearly all cases multi-nuclear giant cells surrounded the bodies. These and other large uninuclear cells appeared to play the part of phagocytes. Sometimes the surface of the body showed an excavation at the point of contact with a giant cell, recalling the appearance of a Howship's lacuna in bone. What were identified as fragments of bodies were also seen in giant cells. The author refrained from suggesting any hypothesis with regard to the cause or origin of the bodies.

According to A. Zimmermann,* Iwanoff, in 1890, described amyloid bodies as constant constituents of the colostrum of cows, and Martin is said to have found them in the milk of all the domestic animals. Lenfers (1907) found them most frequently in the udder of cows going dry, while Winkler found them in great numbers in the colostrum, but also in other stages of lactation, and regarded them as somewhat regular constituents of milk. The article by Zimmermann is accompanied by drawings showing the structure of these bodies as found in the cow's udder and illustrating what the author believed to be the different stages in their formation. He found them to be most frequent in old animals, although they were also found in young ones, and their presence appeared to have no relation either to the age of the animals or the lactation period. From ten to twelve were often found in a single alveolus, and one might find the whole cavity of one alveolus filled with them while none were present in the neighbouring alveoli. Although most frequently found free in the alveoli, they were also found in the epithelial layer, projecting between the cells as far as the basement membrane ; occasionally they were found in the connective tissue between the alveoli. The smallest were always found in the alveoli, and this appeared to indicate that they were first formed in that position and subsequently got into connective tissue through disappearance of the alveolar epithelium. With Lugol's solution they stained a yellowish-red and with the addition of 10 per cent. sulphuric acid they stained a darker brownish red. With the concentrated solution of Sudan III in alcohol they stained an orange-yellow colour. With aniline dyes they regularly stained like the amyloid substance and the corpora amylacea of the prostate, but on account of their failure to give a blue reaction with iodine followed by sulphuric acid the author thought they could not be considered true corpora amylacea. He inferred from their micro-chemical reactions that they were of a lipoid nature in spite of the fact that they were resistant to the solvent action of chloroform and ether. He thought, however, that this might be attributable to the method of examination, and when sections were dehydrated with frequent changes of alcohol warm chloroform dissolved the bodies within half an hour. He was not able to come to any firm opinion with regard to the source and cause of formation of the bodies. The presence of a central nucleus suggested that the bodies might be formed like the concretions around foreign bodies. He could not agree with Winkler that the bodies were formed from degenerated epithelial cells, for he found bodies already stratified that were only half as large as the nucleus of the epithelial cell. The central part of the youngest body never showed a structure from which one could infer its origin, and they therefore appeared to be formed by some chemico-physical process. There were also indications that fragments of degenerated bodies might serve as the starting point for new ones. Bodies in what appeared to be a stage of solution commencing at the surface were often observed. The cause of the degeneration which attacked the bodies was not clear.

* Zeitschr. für Fleisch, und Milchhygiene, Bd. XIX, 1909, p. 425.

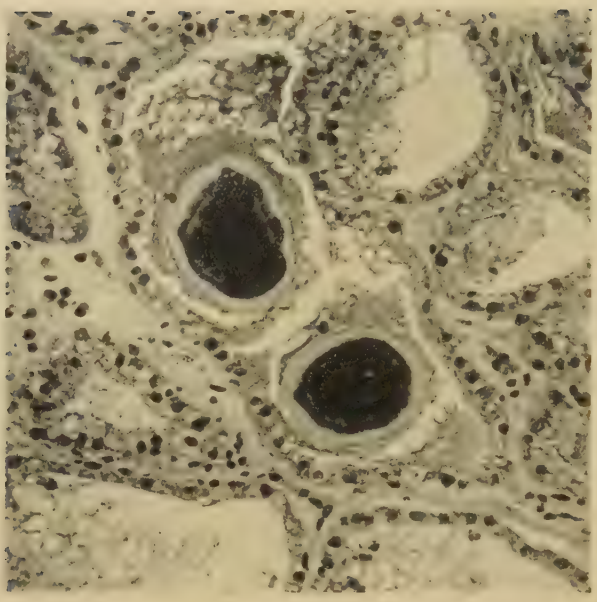

FIG. 3.

Shows two bodies, each with central dark hæmatoxylin-stained nucleus surrounded by a faintly stained (eosin) stratum. × 275.

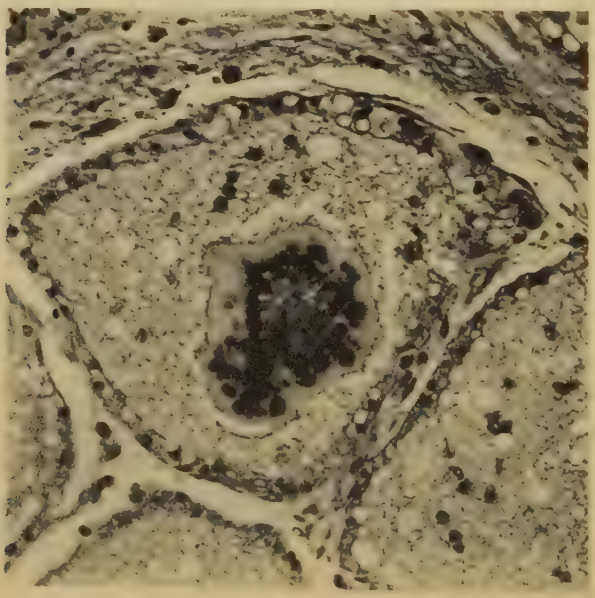

FIG. 4.

Shows a body in a functioning alveolus. The central part is more complex than usual and is surrounded by a stratum faintly stained with eosin. × 280.

An article by Joest and Steck* (1924) gives a more complete account of the amyloid bodies of the cow's udder than is found in any previous publication. After a reference to previous investigations the authors describe the results of their own observations, and a number of drawings showing the position and appearance of the amyloid bodies are appended. They did not find any constant relationship between the number of the bodies present and the stage of lactation. The bodies occurred in an interalveolar position as well as free in the alveoli or excretory ducts. The presence of the large special cells, like giant cells or large phagocytes, described by Ottolenghi were never observed, but occasionally irregular cells with shrunken nuclei, and apparently desquamated epithelial cells often, occurred in the immediate neighbourhood of the bodies lying in the alveoli. With regard to the formation of the bodies, the authors were of opinion that their formation began within the epithelial layer of the alveoli, and not external to the basement membrane of the epithelium or in the alveolar cavities. They believed that the bodies found apparently in an interalveolar position in sections were also originally formed in the epithelial layer. The article gives a full account of the affinity of the bodies for various stains. When stained by Gram's method the bodies were generally decolourised as quickly as the surrounding tissue. When they retained the gentian violet stain better the colour was rose red ; very rarely parts of a body remained of a violet colour. The bodies were thus found to be as a rule Gram-negative.

With Sudan III they did not give the red colour characteristic of fat, but only a scarcely recognisable yellowish tint. With Lugol's solution they never showed the mahogany brown colour of the true amyloid material, and iodine staining followed by sulphuric acid never produced a violet or blue tint. With silver staining the bodies stained deeply, generally black. It was not found possible by any of the staining methods employed to stain all the bodies present in a uniform and characteristic colour, and Zimmermann's statement that after dehydration in absolute alcohol the bodies are soluble in chloroform was not confirmed. A series of tests with reagents for albumen did not yield conclusive results, but, nevertheless, the authors thought it probable that albumen is an essential constituent of these bodies.

Mention may also be made here of Wederhake's (1905) account of the occurrence of corpora amylacea in an article dealing with the morphology of human colostrum.† .

In the colostrum of three women he found in each case large numbers of bodies which, in their structure, chemical and staining reactions, and number, differed in no way from the amyloid bodies found in the prostate, lung, etc. The majority of them stained blue or black-blue with iodine alone, but others showed the characteristic staining with iodine and sulphuric acid. He pointed out that the larger could be seen with the naked eye. Many of the bodies showed a distinct central part with a sharp contour towards the surrounding substance. In the centre many of the bodies showed a fissure, or three or four fissures radiating from the central point. The substance of many of the bodies, however, was so compact that neither concentric layers nor radial striæ could be recognised. The author was of the opinion that the amyloid bodies found in the colostrum were formed from degenerated epithelial cells or leucocytes, which was the opinion commonly held with regard to the origin of similar bodies in the prostate. It appeared as if the nuclei of the

* Zeits. für Infektionskrank., par. Krankh. und Hyg. der Haust. Band. XXVI, 1924, pp. 21-44.

† Monatsch. für Gebürtshilfe und Gynáek. Bd. XXII. 1905, p. 630.

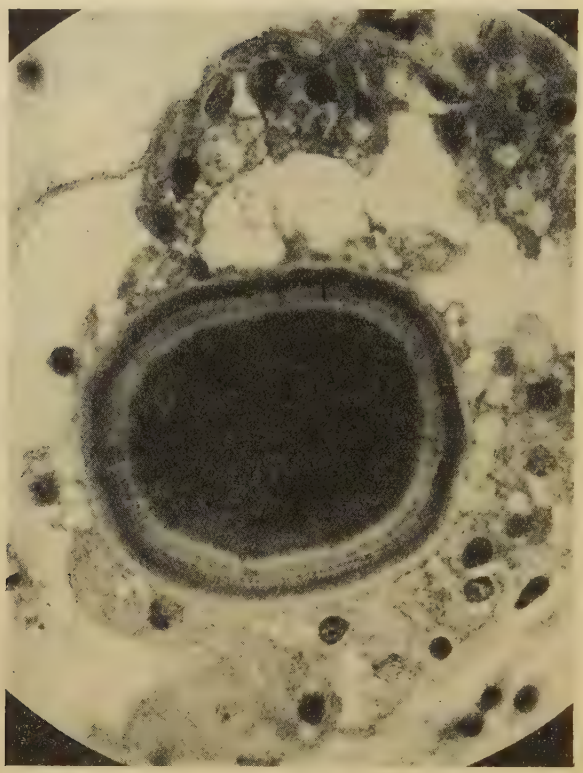

FIG. 5.
A body with a relatively large centre and an envelope that shows both concentric and radial markings. × 800.

cells underwent amyloid degeneration and that these nuclei united with the degenerated protoplasm and the albumen of the surrounding menstruum and thus gradually built up the bodies. He thought the best conditions for the development of the bodies of the mammary glands occurred during the resting period, during which the large numbers of dying or dead cells are found in the ducts.

It should be noted that this author's observations were made entirely on the liquid colostrum or milk, and that his opinions were not based on any microscopic examination of the mammary glands.

The foregoing extracts make it evident that corpora amylacea are of very common occurrence in the udders of cows, but it would be a mistake to assert that they are constantly present. At any rate, the author has examined many sections from certain udders without finding any bodies, and he has never met with them in such numbers as Zimmermann's description would lead one to expect.

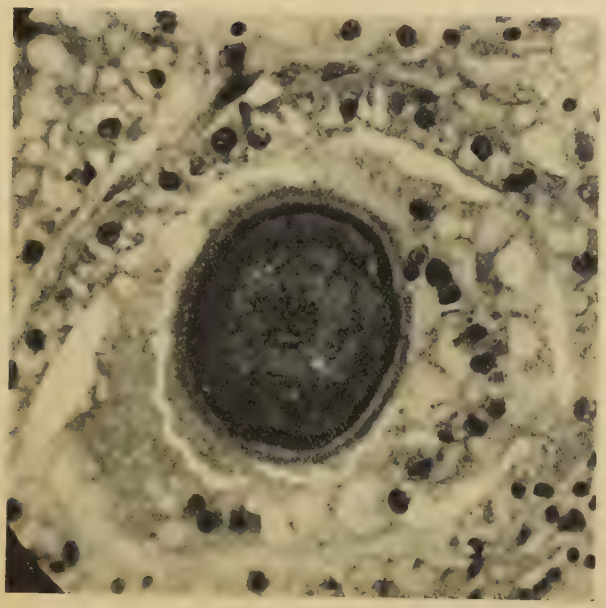

FIG. 6.
A body in which a deposit of apparently calcareous particles was forming in the centre. Three strata are distinguishable in the surrounding substance. × 700.

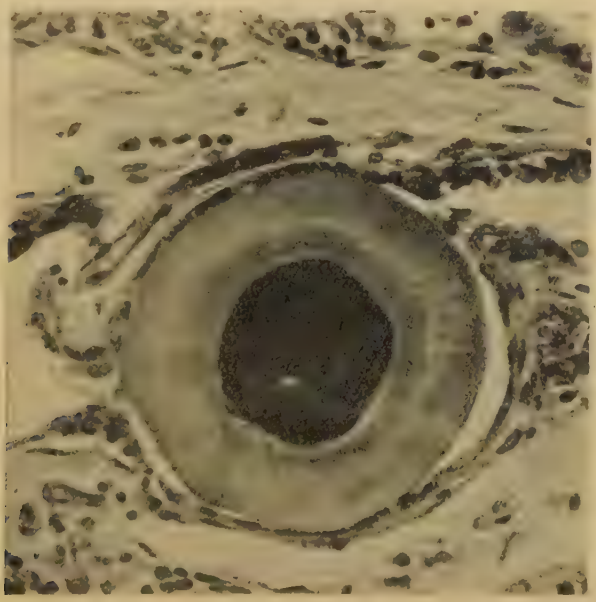

FIG. 7.
A body with the usual nucleus deeply stained with hæmatoxylin, and a relatively thick eosin-stained envelope. The alveolar epithelium is compressed and atrophied, but does not appear to be playing any part in the formation of the body. The light speck in the centre part of the body is the result of a " pinhole " defect in the photograph plate. × 435.

The point with regard to the structure and appearance of the bodies that seems to require emphasis is that the immense majority are not composed of the same material throughout. All authors appear to be agreed that everything that can with certainty be microscopically identified as one of the bodies in question has a stratified structure, but an equally important fact is that in respect of their staining reaction the different strata in the same body are different. That fact is constantly brought out with great distinctness in sections stained by the hæmatorylin and eosin method, and, such being the case, any attempt to identify the substance of the bodies as a whole with Virchow's amyloid substance is vain. In fact, however, it appears that no part of any of the bodies gives the characteristic colour reaction of the genuine amyloid substance with methyl violet, or with iodine alone or followed by sulphuric acid.

With one exception (No. 7), all the accompanying figures were from the same udder. All were from pieces of tissue fixed with 10 per cent. formalin in normal saline and embedded in paraffin, and the sections were stained with hæmatorylin and eosin. In all, the darker portions of the bodies are those that took the hæmatoxylin tint and the lighter showed an eosin shade of varying intensity.

As previously stated, it does not appear to be possible to identify with certainty any object as the starting point or nucleus of one of these bodies unless it shows at least two distinct strata. In spite of a careful search, no clear evidence that degenerated nuclei lay the foundation of the bodies has been found. The dark body in the alveolus in Fig. 1 may represent the earliest stage in the formation of a body, and the two dark objects in Fig. 2 may be accepted as bodies at a more advanced stage, but not definitely stratified. In that figure, the space surrounding one of the bodies has obviously been formed by contraction of the milk coagulum in the process of fixation.

In the lower part of the epithelial lining of the alveolus in Fig. 2 there is seen the smallest distinct body met with in the same udder. The author has not been able to find convincing evidence that this is the usual starting point of the bodies, and he inclines to the view that the majority are *ab initio* free in the alveolus. He has not seen any external to the alveolar wall.

In regard to the origin of the bodies, the author cannot agree with Joest and Steck that they are formed exclusively in the epithelial lining of the alveoli. That, one must admit, is a matter about which there can hardly be certainty, but in the present author's observations the immense majority of the bodies have been lying free in alveoli, and nothing in their appearance has suggested that epithelial or other cells play any part in what may be called the growth of the bodies. It is hardly conceivable that the bodies have a stratified structure from the outset, and there is admitted difficulty in identifying any clump of amorphous material in an alveolus as the beginning of a body. It cannot be doubted, however, that the central part of any of the bodies was the first formed, and an important fact in that

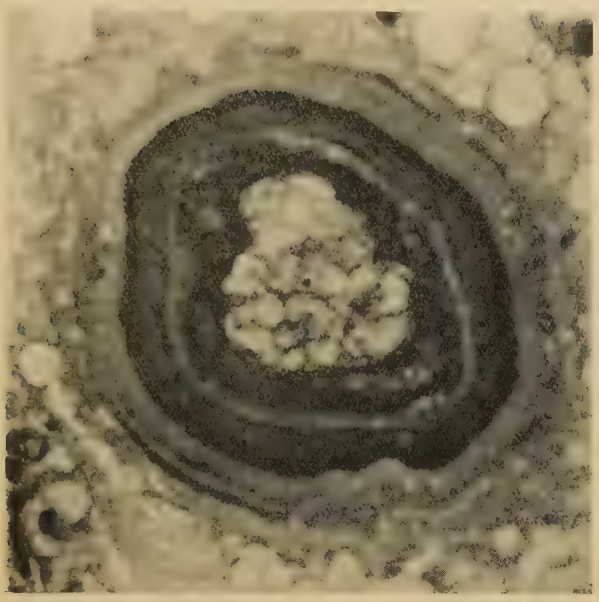

FIG. 8.

An apparently old body with an unusually complex structure. An area in the centre appears to have become almost completely impregnated with mineral matter and the outer part shows several strata distinguished by varying affixities for hæmtaoxylin and eosin. × 750.

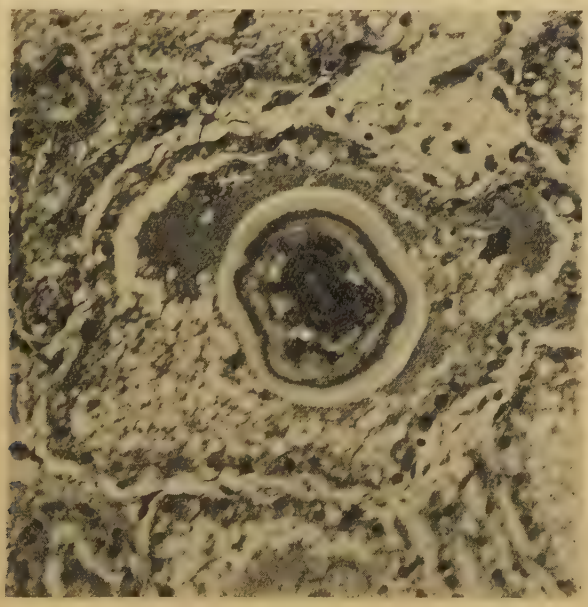

FIG. 9.

Shows a body with an unusually complex structure. × 275.

connection is that this nucleus shows neither concentric nor radial markings, and is further distinguished by its basophil staining tendency.

It therefore seems probable that, once this central part has taken definite form, the further increase of the body in size is by a process of precipitation or accretion of materials from the surrounding liquid in the alveolus.

The author has never seen a body occupying an inter-alveolar position in a part in which the normal alveolar structure of the gland remained, but in a tuberculous udder the bodies may be found in the newly formed tuberculous tissue which has replaced the normal secreting tissue of the udder. In such a position the bodies tend to lose their characteristic appearance, and eventually to become more or less completely calcified. Such bodies often break under the razor's edge in section cutting, and in the early stage of calcification they stain intensely with hæmatoxylin. This deposition of earthy salts is quite independent of that which affects the tuberculous tissue as such, and occurs in parts still free from necrosis and caseation.

Amyloid bodies thus caught in tuberculous new tissue are also liable to partial removal by a process of solution for which the surrounding cells appear to be responsible, and this may occur without the immediate presence of giant cells. Under this process of erosion the bodies sometimes acquire bizarre shapes, and these may be fixed by the calcification, which arrests the process of absorption. It must be noted that the bodies occupying an intra-alveolar position in otherwise normal udder tissue show little tendency to these retrogressive changes and have a texture and consistence that make it possible to section them perfectly without tear or fracture, as the accompanying photographs show.

It is obvious that the bodies have no claim to the adjective amyloid if it be not that their stratified appearance gives them a certain resemblance to starch grains. On a miniature scale, however, this stratification bears a much closer resemblance to that of some of urinary calculi of mixed chemical composition.

In conclusion, one can only re-echo the desire expressed by Joest and Steck that further research covering the relative frequency and numbers in which the bodies occur in cows of different ages, under different régimes, and at different stages of lactation, may clear up the obscurity that still hangs around the cause of their formation.

RINDERPEST IN GOATS IN NIGERIA.

By W. G. Beaton, m.r.c.v.s.,
Research Officer, Veterinary Laboratory, Vom, N. Nigeria.

During experimental work on the study of Contagious Pleuro-Pneumonia of Goats, numerous exacerbations of temperature, certain constant symptoms, and some deaths amongst the experimental animals, could not be attributed to the disease in question but simulated Rinderpest. It was therefore deemed advisable to study Rinderpest in goats in Nigeria, to note all the phases of the typical disease, and to establish the separate existence of the two conditions in goats in the country.

Owing to the nature of the routine work at these laboratories, *i.e.*, the production of anti-rinderpest serum, a known bovine virulent strain of rinderpest is always available, and this greatly facilitated the study and control of the disease in goats. On the other hand, the gross contamination of the premises, and the difficulty of impressing upon native labour the importance of isolation, has caused the repetition of much of the work owing to a possible doubt as to the exact interpretation.

These repetitions were invaluable, however, in confirming results.

The following conclusions are based on the clinical observations of over a dozen goats which reacted to inoculations of virulent blood.

General Symptoms.

There is an incubation period of four or five days, the first indication of infection being a rise of temperature; a dry staring coat is then observed, and the animal is disinclined to feed and takes small draughts of water frequently.

About the seventh or eighth day there is some softening of the fæces, the normal pellet formation being lost.

Buccal discomfort is manifested by the continual protruding and retracting of the tongue, which act also removes the now commencing mucoid nasal discharge. There is some waxy lachrymation. Examination of the mouth reveals distension of the vessels of the gums, and about the tenth to fourteenth day fine pin-point eruptions are noticeable on the upper lip and gums; these later extend to the lower lip, and in a day or two a thick furry deposit is present on the tongue and inner surface of lips. There is usually some frothiness at the commisures. The perpetual working of the tongue removes a great deal of the deposit, leaving a raw surface which may be visible at the commisures.

About the twelfth to fourteenth day respiration becomes a little distressed, and a cough may be present. The animal is dull and listless, and refuses food and water. If death is the ultimate result, all symptoms become exaggerated, especially the pulmonary ones, and diarrhœa is profuse.

Death takes place during the third week. As a rule, in recovering

animals there is a rapid return to normal in the third week, and the resperatory distress is never marked.

A comparison of the symptoms with those of the typical bovine infection shows a marked similarity except that the onset of mouth lesions is retarded in the goat to after the tenth day at the earliest, and the pulmonary complication is rare in bovines, whereas in the goat this latter is more common, and is the deciding factor in the ultimate termination of the course of the disease.

Whether the pneumonia is specific of Rinderpest, or only another instance of the marked predisposition of this species of animal to pneumonia following other indispositions, is difficult to say. Experimental rinderpest in goats in this country is usually mild and non-fatal, but a characteristic of all post-mortems following a severe reaction is a marked broncho-pneumonia.

Temperature Reaction. After several years' experimental work with the goat in this country, it may be concluded that the normal temperature of the species varies considerably, but a temperature of 103° F. or over was considered pathological.

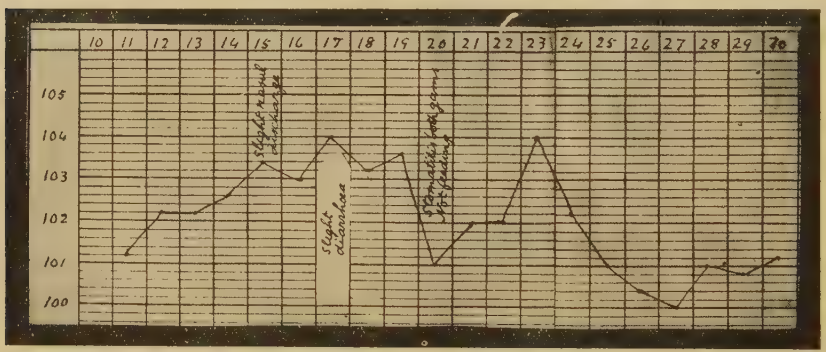

Chart I. Goat 364.

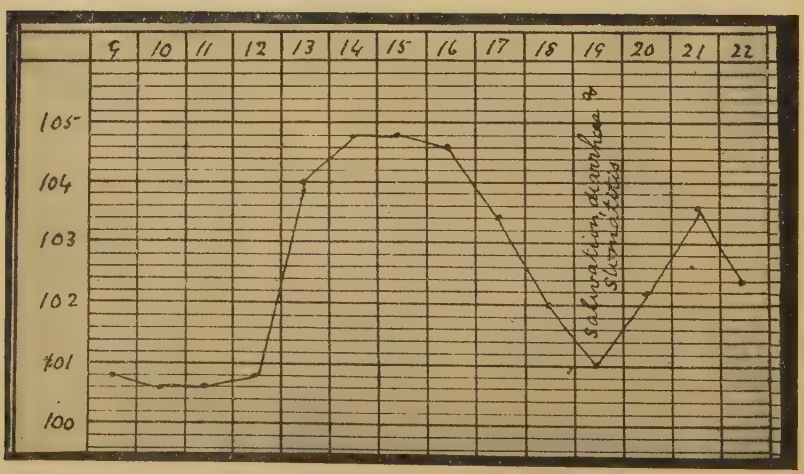

Chart II. Goat 501.

The above temperature reaction of goat 364 may be considered as fairly typical of mild infection and recovery, and that of goat 501 as that of a more severe reaction with fatal termination.

In the first case there was a gradual rise from the date of inoculation to fifth day, when 103·4° F. was reached, with a maximum of 104° F. on seventh day. There was a drop to normal on tenth day, with a further exacerbation on thirteenth day on the first appearance of mouth lesions. From this there is a drop to normal, and a complete recovery in third week.

In the fatal case a sudden rise to 104° F. is noticed on the fifth and remains elevated until the tenth, when it drops to normal for one day. Again, there is a secondary less elevated curve of pyrexia from twelfth to eighteenth day from inoculation, on the onset of mouth lesions.

Pathological Anatomy.

External Appearances. Carcase slightly emaciated, hind quarters stained with diarrhœa, lips thickened at the commisures with some scabs.

Mouth. Congestion of mucous membrane, some healing ulcers.

Pharynx. Ditto, with diphtheresis.

Oesophagus. Congestion of mucous membrane of the anterior extremity. Glands swollen and congested.

Abomasum. Numerous petechiæ of glandular portion and two ulcers at pylorus.

Duodenum. Mucous membrane congested, with diphtheresis.

Cæcum. Acute congestion throughout.

Rectum. Rare petechiæ at posterior end; contents fluid and mucoid.

Liver. Slightly thickened, and evidence of some fatty degeneration.

Gall-Bladder. Bile dark but fluid. Slight congestion and diphtheresis of mucous membrane.

Kidneys. Congestion of cortex. Otherwise apparently normal.

Genital Organs. Visible mucous membrane of vulva congested.

Thoracic Cavity. A unilateral or bilateral congestion of costal wall, with some pleurisy.

Trachea. Some congestion of mucous membrane.

Lungs. One or both lungs show areas of consolidation, especially in the anterior and superior portions. Pleura congested, and some commencing adhesions. There appears to be a contraction of the interalveolar septa, causing a minute bulging of the alveolar spaces over the whole affected surface. On section a thin white exudate appears.

Pericardium. Congestion of the vessels and extension of pleurisy.

Heart. Nothing unusual; the coronary vessels may be congested.

Spleen. May or may not be slightly enlarged and a little more pulpy than usual.

No histological examination was made.

Pathogenicity.

Inter-transmission experiments with the bovine strain and the goat strain of Rinderpest were made with a view to proving that they are one and the same. Goats may be infected with the typical disease by inoculation of bovine blood or contact with infected bovines, and bovines will show typical rinderpest when inoculated with goat blood or placed in contact with infected goats.

The following are single typical examples of these transmission experiments.

Hereafter the word " blood " means Rinderpest virulent blood.

I. Infectivity of Bovine Blood for Goats.

Goats 364 and 370 each inoculated subcutaneously with 5 c.c. blood of virus-producer, Bovine 1586. This bovine on the seventh day since inoculation with blood was bled to death for hyper-immunisation of serum-makers. His temperature was 104·4° F., and he showed diarrhœa and stomatitis. Virus producers Nos. 1588 and 1590, inoculated with this blood, reacted in usual way during the following week.

Goat 364. Temperature rose gradually to 103·4° F. on the fifth day, maximum 104° F. on the seventh day, when diarrhœa was first noticed. It dropped to normal on tenth day, and then rose again on second curve to 104° F. on thirteenth day, when slight stomatitis was noticed ; it then became normal, and remained so from fifteenth day onwards, the animal making an interrupted recovery.

Goat 370. Temperature rose suddenly on fourth and fifth day to 104° F. (on latter day).

Dropped to 102·6° F. on ninth day, when discharge from eyes and nostrils was present ; it rose again gradually to 104·4° F. on thirteenth, and became normal from sixteenth onward. No stomatitis was seen, but animal appeared most sick on thirteenth day.

The recovery was uninterrupted.

Neither was tested again with bovine blood, but, to prove that the reaction was due to Rinderpest, Bovine 1594 in Part II was inoculated with blood of Goat 370 on seventh day, and it reacted to Rinderpest in the usual way. (*Vide* Part II.)

II. Infectivity of Goat Blood for Bovines and Other Goats.

Rinderpest susceptible Bovine 1594 and Goat 368 were inoculated with 5 c.c. blood of Goat 370, taken on the seventh day from inoculation (*vide* Part I), when temperature was 104·2° F. Reactions were as follows :

Bovine 1594. Temperature rose suddenly to 103·4° F. on fourth day, 105° F. on fifth day, and maximum 105·4° F. on seventh day. There was acute stomatitis and typical diarrhœa, when bled to death for hyper-immunisation purposes on the eighth day. Post-mortem showed the typical Rinderpest gastro-enteritis, though somewhat milder than was to be expected after the marked clinical reaction.

The blood was proved by sub-inoculation into Bovine 1629 in

Part V and Bovine 1626—virus producer, both of which gave the usual reactions, and were bled to death.

Goat 368. A gradual rise in temperature to 103·4° F. on sixth day, maximum 104·4° F. on seventh day; from this onwards to sixteenth day there was a steady decline to 101° F., and complete recovery.

Symptoms were very mild, the animal being merely " off colour."

III. Infection of Goats by Contact with Reacting Goats.

Goat 365 placed in contact with Goat 370 (in Part I) on the seventh day from its inoculation. The temperature of Goat 370 on that day was 104° F., but there were no visible discharges. On the fourth day of contact temperature rose to 103° F., and to a maximum of 105° F. on sixth and seventh days. It remained elevated between 103° F. and 105° F. until fourteenth and then dropped steadily to 102° F. on sixteenth day. Recovered. There were no mouth lesions on seventh day, but a suspicion of diarrhœa. On twelfth day, however, stomatitis was marked, affording the most acute clinical picture seen in the series.

For several days afterwards the mouth was typical of that of a bovine about the tenth to twelfth day after infection, there being acute exfoliation of the mucous membrane of gums, lips, and tongue. Recovery was complete in one month. Blood was taken from this goat on seventh day, when the temperature was 105° F., and passed into a goat 359 and Rinderpest susceptible Bovine 1629. Both contracted rinderpest though somewhat mildly. (*Vide* Part IV.)

IV. Infectivity of Contact Strain of Goat Blood for Goats and Bovines.

Goat 359 and Rinderpest Susceptible Bovine 1628 were each inoculated subcutaneously with 5 c.c. blood of Goat 365 (in Part III). The temperature at the time of bleeding was 105° F.

Symptoms were negligible.

Goat 359. Temperature rose gradually to 103·4° F. on fourth day. This was the maximum also. It declined to normal on eighth day, and no lesions beyond some hyperæmia of the gums were noticeable. Though very mild, the reaction was considered a positive one in view of the reaction of Bovine 1628, but no test was made either by sub-inoculation or further inoculation with blood.

Bovine 1628. Temperature rose gradually to 102·8° F. on fifth day, and remained at this for three days. Acute stomatitis was present, and the animal was bled to death for virulent blood on eighth day. This temperature reaction was very mild, but the lesions typical. This type of clinical reaction is not an uncommon one in batches of virus producers inoculated from the passage strain.

V. Infectivity of First Passage Goat Strain in Bovines for Goats and Bovines.

Bovine 1594 (*vide* Part II) gave a typical rinderpest reaction when inoculated with goat blood. On the seventh day, when temperature

was 105·2° F. and stomatitis was present, Bovine 1594 was bled, and Goat 381 and Bovine 1629 were each inoculated with 5 c.c. citrated blood.

Goat 381. Temperature rose to 104·6° F. on fourth day, declined to 102° F. on tenth, and rose again to 105·6° F. on twelfth day, when symptoms were marked salivation, stomatitis, lachrymation, and diarrhœa.

The temperature dropped to normal on sixteenth day, but became elevated again, and in a further 16 days the animal died of acute peritonitis.

Post-mortem unfortunately was not sufficiently detailed to prove that death was a direct cause of the severe intestinal disturbance from Rinderpest reaction.

Bovine 1629. Temperature rose abruptly to 103·6° F. on third day, and reached a maximum of 104·6° F. on seventh, when diarrhœa and stomatitis were present. The animal was bled to death on eighth day for hyper-immunisation of serum makers.

VI. Infectivity of Reacting Bovines for Goats in Contact.

Goats 503 and 505 were placed in contact with a batch of the routine virus producers, some of which were at the height of their reaction, and others only inoculated with blood the previous day.

The reactions were as follows :

Goat 503. Temperature rose suddenly on eighth day to 104° F., remained about this for four days, and then gradually came down to 100·6° F. on sixteenth day, when the animal died. Symptoms were mild, but there was a severe cough on the last few days.

Post-mortem revealed mild enteritis, with marked pneumonia and pleurisy. Sub-inoculations of blood were not made.

Goat 505 was in contact, without rise in temperature, until the sixteenth day, when it was found dead. Post-mortem revealed severe internal hæmorrhage, probably due to a kick from one of the bovines.

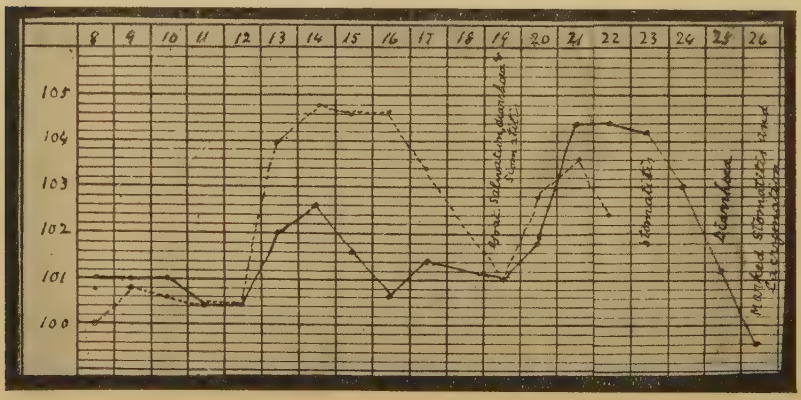

Chart III. Goat 501 (interrupted) and Bovine 16. (See text, p. 307).

Other animals were tried with varying success. No definite incubative period can be fixed from the small numbers of animals tried, but the reaction of Goat 503 is sufficient to prove the possibility of infection of goats from this source.

VII. Infectivity of Reacting Goats for Susceptible Bovines.

Goat 501 inoculated with 2 c.c. blood of Rinderpest virus producer and the presumed rinderpest susceptible Bovine 16 were placed in contact, and both rigidly isolated together. The accompanying chart shows clearly the reactions of both.

As usual, it will be noticed that the lesions in the goat commenced at the end of the first crisis of temperature, causing a secondary rise, while those in the bovine occurred during the height of the first temperature reaction.

The bovine probably became infected on the third day of temperature in the goat, though no discharges were visible. The animals were in a small space and feeding out of the same manger, and an ærogenous transmission was possible.

Summary.

1. Rinderpest in Nigeria has been studied with a view to differentiating the lung lesion in this condition from other specific pneumonias.

2. It has been shown that

(*a*) Goats may be infected with Rinderpest by inoculation with bovine virulent blood.
(*b*) Goat virulent blood produces Rinderpest in bovines and other goats.
(*c*) Goats may be infected by contact with reacting goats.
(*d*) Goats and bovines may be infected by goat blood from contact infection.
(*e*) Goats and bovines may be infected by bovine blood infected with goat strain.
(*f*) Goats may be infected by contact with infective bovines.
(*g*) Bovines may be infected by contact with infective goats.

Further work has been done with the double-inoculation of goats with bovine blood and bovine anti-rinderpest serum, and vaccination with bovine spleen vaccine.

Differentiation of this disease from contagious pleuro-pneumonia, by contact infection of known Rinderpest immune goats with the latter disease, occupied much time also.

I am indebted to Captain Hall, Veterinary Pathologist, for much help in the compiling of this paper from a mass of experimental records, and to Captain Henderson, Chief Veterinary Officer, for permission to publish.

PARADYSENTERY IN YOUNG CHICKS.

By C. A. McGaughey.

From the Department of Bacteriology and Preventive Medicine, University of Manchester.

This paper records a disease in young chicks resembling bacillary white diarrhœa, which presented several unusual features. Six dead chicks, about 14 days old, were received on April 27th, 1930, from Mr. G. C. Marginson, M.R.C.V.S., D.V.S.M. They were out of a batch of 50 hatched under hens from eggs bought from a poultry breeder. About 25 had died after showing signs resembling those of bacillary white diarrhœa. The disease had not spread to chicks hatched from other eggs, although they were in close contact with the diseased birds.

On *post-mortem* examination the intestines were slightly inflamed, the liver in some chicks was mottled, in others apparently normal, the lungs were normal, and the unabsorbed yolk was about the size of a pea, and very firm in consistency.

Cultures from three chicks were made on MacConkey agar plates from the liver, yolk remnant, and blood. The fæces of two chicks were inoculated into brilliant green broth (1 in 50,000), and, after incubation over night, the broth cultures were spread on MacConkey agar plates. After 24 hours' incubation a pure growth of small non-lactose-fermenting colonies was seen on the plates inoculated with liver and yolk from all three chicks, and on one plate inoculated with blood from one chick. Similar colonies were found on plates inoculated with brilliant green broth cultures of the fæces of two chicks. The organism had the following characters :

Morphology. Bacillus, about $2\mu - 3\mu \times 0{\cdot}4\mu$, arranged singly ; non-motile ; Gram-negative.

Colonies on hormone agar after 24 hours at 37° C. were round, opaque, greyish, raised, from 0·5 mm. to 2 mm. in diameter, with smooth surface and entire edge. After 48 hours at 37° C., they increased in size to 3 mm., the edge was slightly undulate, and there was a faint fæcal odour.

Broth cultures became turbid in eight hours, there was no surface scum, no deposit, and no noticeable odour. After three days at 37° C., the broth was still turbid ; there was a small amount of granular deposit and a faint fæcal odour.

Biochemical Reactions. The following substances (1 per cent. solutions in peptone water containing Andrade's indicator) were fermented in 24 hours with the production of acid and gas : glucose, maltose, mannite, and arabinose. There was no change in lactose, sucrose, salicin, xylose, dulcite, and inosite, even after 30 days. Repeated passage through lactose solution did not induce the culture to ferment lactose.

Litmus milk became slightly acid in three days, but not clotted. The reaction then returned to neutral.

H_2S was not formed.

Dextrose phosphate broth cultures were methyl-red positive, Voges-Proskauer negative.

Gelatin stab cultures. Growth occurred along the line of inoculation with the formation of a few bubbles of gas. There was no surface growth, and no liquefaction.

Indol was formed in peptone water cultures after five days' incubation at 37° C.

After several weeks Mr. Marginson informed me that the surviving chicks of the batch of 50 were not thriving but remained small and weakly, whereas chicks hatched from other eggs were healthy and growing well. On June 26th, 1930, one of the survivors was sent alive, but it died in transit. Although 2½ months old, it was small and stunted.

On *post-mortem* examination no definite lesions were noticed; the yolk remnant was about the size of a pea.

Cultures were made on MacConkey agar from the liver, lungs, blood, yolk, and bile; the fæces were inoculated into brilliant green broth, and plated on MacConkey agar after 24 hours' incubation at 37° C. An almost pure growth of the same organism was obtained on the plates inoculated with yolk residue, but the cultures made from the other sources were negative.

Discussion.

The organism appears to be one of the group described as *Dysenteroid* or *Paradysentery* bacteria. As stated by Gardner (1929), this group includes members of the coli-typhoid group which lie somewhere between *B. coli* and *B. dysenteriæ*, sometimes approximating to one, sometimes to the other. The organism isolated in this outbreak approximates most closely to Type 14a of Morgan and Ledingham (1909), isolated from the fæces of children suffering from summer diarrhœa. It seems probable that the infection was transmitted through the egg, as the disease was confined to one lot of chicks hatched from eggs which were bought from another breeder, and also because the organism was recovered in pure culture from the unabsorbed yolk in every case.

The striking features of the outbreak were its causation by an organism of the paradysentery group, its resemblance to bacillary white diarrhœa, its apparent transmission through the egg, and its limitation to chicks hatched from eggs from one source. This naturally suggests that adult carriers occur; the organism was recovered from the yolk residue in a bird 2½ months old. It would appear to have a lower invasive power in a flock than has *B. pullorum.*

References.

Gardner, A. D. 1929. Medical Research Council, System of Bacteriology, iv, 177.

Morgan, H. de R., and Ledingham, J. C. G. 1909. Proc. Roy. Soc. Med., Sec. Epidem., ii, 133.

TUBERCULOSIS OF THE CAT.

By Norman Dobson, B.SC., M.R.C.V.S.

There do not appear to be records of the percentage incidence of tuberculosis of the cat in this country.

Abroad, many workers have published the results of their investigations covering large numbers of post-mortem examinations.

Griffith, A. S. (1), gives the details of seventeen cases of feline tuberculosis, and Cobbett, L. (2), of three, and in every case the causal organism is assigned to the bovine type of the bacillus. Griffith, F. (3), when working for the Royal Commission on Tuberculosis, made quite an extensive study of the experimentally produced disease in cats. Using the bovine type of the tubercle bacillus, it was found that the disease could readily be induced, either by inoculation or by feeding. On the contrary, when the human type of the bacillus was administered with the food it failed to produce the disease, and with a subcutaneous inoculation the result was a localised reaction.

Chaussé, P. (4) carried out feeding experiments with meat from tuberculous animals. He employed fifteen cats, four of which, when examined post-mortem between the 76th and 198th days, were found to be infected with tuberculosis. Three of these infected cats showed thoracic lesions, but in all cases the mesenteric glands were infected.

Chaussé (5) next tried feeding cats with tubercle bacilli from human cases. Eleven cats received six doses of one or two grammes of sputum rich in tubercle bacilli. Between the 48th and 78th days the animals either died or were killed. Post-mortem examination did not reveal a single tuberculous lesion. From these two groups of experiments Chaussé concludes that the human type of the tubercle bacillus is less virulent for the cat than the bovine type.

Chaussé (6 and 7) proceeded to test the receptivity of the cat by inhalation of the human and bovine types of the tubercle bacillus. Using the bovine type, he tried varying quantities in an experiment with ten cats. The post-mortem examinations showed that eight of the ten cats were affected with tuberculosis, showing primary thoracic lesions. The remaining two cats, which had received only a very small dose, gave a negative result. He states that, in his experience, inhalation is the most rapid mode of infection, and more severe than ingestion. He carried out similar tests, employing the human type of the bacillus. Placing dogs, cats, and guinea-pigs under the same conditions, the dogs and guinea-pigs fell victims, whereas the cats were not infected. Increasing the quantity of the organisms to 190 millions in a room of thirteen mètres cubic capacity, infection in four out of the fourteen cats was obtained. Infection was not influenced by the age of the animals.

Galli-Valerio, B., and Bornand, M. (8), working at Lausanne, made post-mortem examinations on one hundred cats, and found two affected with tuberculosis. Both of these cases were due to the bovine type of the bacillus.

From the experimental evidence put forward by the Royal Commission and other workers, it is clearly indicated that the bovine strain of the tubercle bacillus has a much greater virulence for the cat than the human type.

Acting on the suggestion of Professor J. Russell Greig, that a knowledge of the incidence of feline tuberculosis was highly desirable, I commenced a series of post-mortem examinations in Edinburgh, in October, 1925, and continued until June, 1927, with the exception of a break of nine months in 1926. During this period, 505 cats were examined, and out of that number eleven were proved to be infected with tuberculosis.

The following particulars of these eleven cases give the available history, the ante-mortem and post-mortem findings, and the results of bacteriological and biological examinations.

Case No. 1.

History.—A male cat, one year old, was brought for treatment of an open wound. The owner stated that a discharge was noticed about a fortnight before, and since then the wound had been treated by antiseptic baths and dressings.

Ante-mortem Examination.—The cat was very emaciated, and a marked degree of ascites was present. On the left side of the head a wound discharging thick pus of a yellowish-green colour was noted. Also below the left ear a swelling, and when pressure was applied to this part an increased quantity of pus flowed from the wound. Bacteriological examination of the discharge showed tubercle bacilli to be present in large numbers. The following morning the cat was found dead.

Post-mortem Examination.—Opening up the facial wound, it was found to be connected with the swelling below the ear. There was much destruction of the surrounding tissue, and a large amount of pus with a nauseating odour. The submaxillary and cervical glands on the left side were caseous and necrotic, but not those of the right side, which were enlarged.

The lungs were congested, and showed many caseous tubercles, the largest being one centimetre in diameter. The mediastinal glands contained small caseous areas. The ascitic fluid was almost colourless and transparent, and measured 320 c.c.

The liver, spleen, kidneys, and mesenteric glands were free from macroscopic lesions.

Bacteriological and Biological Investigation.—An emulsion of the submaxillary gland inoculated subcutaneously into a guinea-pig caused generalised tuberculosis. Cultures from the glands were dysgonic. A rabbit inoculated subcutaneously with one milligram of a primary culture died of generalised tuberculosis in forty-eight days.

Case No. 2.—Adult male grey cat.

History.—The owner stated that the cat had gradually become thinner, although no inappetence had been shown.

Ante-mortem Examination.—The cat was found to be very thin, and palpation of the abdomen detected a large firm mass in the median line.

Post-mortem Examination.—The lungs and thoracic glands were normal. The liver was enlarged and congested, showing several large rounded lesions projecting from the surface of the organ. The largest measured 1·5 c.m. in diameter. The kidneys were very fatty, the spleen normal. The mesenteric lymph glands were enlarged and fused into a rounded mass, to which portions of the intestine were adherent in a twisted manner. Smears from the mesenteric glands showed the presence of tubercle bacilli in large numbers.

Bacteriological and Biological Investigation.—An emulsion of the mesenteric glands inoculated subcutaneously into a guinea-pig caused generalised tuberculosis. Cultures from the mesenteric glands were dysgonic. A rabbit inoculated with one milligram of the primary culture died of generalised tuberculosis on the thirty-second day.

Case No. 3.—Adult female cat, light grey.

Post-mortem Examination.—A swollen area about 3 c.m. in diameter was found on the right side of the neck below the parotid gland, with a small wound discharging a thick yellow pus. Enlarging the wound showed a quantity of thick, blood-stained pus, which contained tubercle bacilli. The parotid and cervical glands did not show tuberculous lesions. The lungs contained miliary tubercles of a buff grey colour in large numbers.

The liver was quite normal, whereas the spleen presented six whitish nodules, the largest about 0·5 c.m. in diameter, and the outer surface of the lesions was slightly depressed below the general level of the capsule. The right kidney on section showed a lesion about 1 c.m. in diameter, situated near the pelvis. The left kidney was quite normal. The mesenteric glands were fused together, and on section parts were found to be quite firm with fibroid tissue. Several areas were found where the glandular tissue had degenerated, and consisted of a substance of cheesy consistency; pressure around these areas caused them to come away, leaving a cavity.

Tubercle bacilli were found in the glands in large numbers. The horns of the uterus were much enlarged, and the walls thickened. Examination of the interior of the uterus and horns showed a large quantity of pale yellow viscid pus. Tubercle bacilli could not be demonstrated in this material.

Bacteriological and Biological Investigation.—An emulsion of spleen tissue inoculated subcutaneously into a guinea-pig caused acute generalised tuberculosis. Cultures from the mesenteric glands were dysgonic. A rabbit inoculated subcutaneously with one milligram of the primary culture died of generalised tuberculosis in thirty-one days.

Case No. 4.—Adult male cat, black. No history.

Post-mortem Examination.—The cat was in a very emaciated condition. Pericardium contained a small quantity of serous fluid, and the lungs were congested.

The abdominal cavity contained a large quantity of clear fluid. The liver was much enlarged and the lobulation well marked. The spleen also was enlarged, but neither in the liver nor the spleen were tuberculous lesions found.

On the parietal surface of the small intestine, in its posterior third, a yellow nodule of the grape type was found. The parietal peritoneum showed no such lesions. The omentum was in places wrapped around the intestines in a very intimate manner, but no adhesions between the omentum and the visceral or parietal peritoneum had occurred. The mesentery was almost non-existent. Its depth was occupied by a hard nodular mass, about 8 c.m. in diameter, of the fused mesenteric glands, and to this mass the intestines were firmly attached. Incision of the mass showed it to be of a fibrous nature, with large areas, some 0·5 c.m. in diameter, which were caseous and of a yellow or greenish colour. Impression preparations of the yellow substance showed tubercle bacilli to be present in very large numbers.

The iliac lymph glands were enlarged, but did not show any macroscopic change.

Bacteriological and Biological Investigation.—An emulsion of the mesen-

teric glands inoculated subcutaneously into a guinea-pig caused generalised tuberculosis. Cultures from the same glands were dysgonic.

A rabbit inoculated subcutaneously with one milligram of the primary culture died of generalised tuberculosis in forty-six days.

Case No. 5.—Adult female grey cat. No history.

Post-mortem Examination.—The musculature was very wasted and the body in very poor condition.

The lungs showed several areas of congestion.

The omentum, instead of being in its normal position, was knotted and twisted, and lying on the left side of the abdomen, and attempts to spread it out showed adhesions, including one very strong attachment to the left ovary.

Immediately under the capsule of the kidneys, numerous small white areas were noticed, and were found to contain tubercle bacilli. The adrenal glands, although enlarged, did not show macroscopic changes. The pancreas was enlarged, but showed no tuberculous lesions.

Bacteriological and Biological Findings.—An emulsion of the infected organs inoculated subcutaneously into a guinea-pig caused generalised tuberculosis, with death in forty-two days. Cultures from the infected tissues were dysgonic. A rabbit inoculated subcutaneously with one milligram of the primary culture died of generalised tuberculosis in sixty-two days.

Case No. 6.—Adult female grey cat. No history.

Post-mortem Examination.—The animal was found to be in very good condition and well nourished. The mesenteric lymph glands were fused and enlarged, and incision of the mass showed five small yellow caseous nodules. Tubercle bacilli were demonstrated in material from one of the nodules.

No trace of any other lesions could be found.

An emulsion of the mesenteric glands inoculated subcutaneously into a guinea-pig caused generalised tuberculosis, with death in twenty-six days. Cultures from the infected glands were dysgonic. A rabbit inoculated subcutaneously with one milligram of the primary culture died of generalised tuberculosis in thirty-nine days.

Case No. 7.—Adult female, black and white cat.

History.—The owner stated that during the previous month the cat had not taken the usual quantity of food and her appetite seemed capricious. The animal had not lost condition, but a gradually increasing swelling of the abdomen had been noticed during the last few days.

Ante-mortem Examination.—The cat was found to be in very good condition, with no sign of wasting, and the excellence of the coat attracted attention. A condition of ascites was obvious, and some of the fluid collected was found to contain tubercle bacilli.

Post-mortem Examination.—About 400 c.c. of ascitic fluid of a greyish colour was collected, and floating in it were numerous yellow particles. The spleen, kidneys, liver, intestine, mesentery, and peritoneum were all thickly coated with this yellow substance, the deposit being thickest on the liver. The mesentery and peritoneum also showed large inflamed areas. The mesenteric glands were fused, and from the surface of the glands the deposit of a green to yellow colour could easily be removed by gentle scraping with a scalpel. The deposit was found to be very rich in tubercle bacilli. Section of the fused mesenteric glands showed several caseous areas.

Bacteriological and Biological Investigation.—An emulsion of mesenteric glands was inoculated subcutaneously into a guinea-pig, and ascitic fluid inoculated intraperitoneally into another guinea-pig. Both died, showing lesions of generalised tuberculosis, the first in nineteen days and the other in twenty-seven days. Cultures from the mesenteric glands were dysgonic. A rabbit inoculated subcutaneously with one milligram of the primary culture died of generalised tuberculosis in twenty-five days.

Case No. 8.—Adult male, black and white cat. No history.

Post-mortem Examination.—The body was found to be in very good condition. Over the trachea was found an old ulcer, which was wet and shiny, but pressure around the parts did not cause any flow of discharge. The left submaxillary gland was enlarged. The lungs showed miliary tuberculosis, and the mediastinal glands were slightly enlarged.

The mesenteric glands were fused, and on the surface were some small yellow nodules presenting an appearance not unlike that of tubercle colonies on artificial media.

Bacteriological and Biological Investigation.—Tubercle bacilli were present in large numbers in the open wound and in the submaxillary and mesenteric glands. An emulsion of the mesenteric glands inoculated subcutaneously into a guinea-pig caused death from generalised tuberculosis in twenty-eight days. Cultures from the infected glands were dysgonic. A rabbit inoculated subcutaneously with one milligram of the primary culture died of generalised tuberculosis in forty-one days.

Case No. 9.—Adult female black cat. No history.

Post-mortem Examination.—The animal was very emaciated.

The thoracic cavity contained a small quantity of straw-coloured fluid, and the lungs were covered with a thick fibrinous deposit; there were small lesions in the substance of the lung. The mediastinal lymph glands were normal. The abdominal cavity contained a very large quantity of fluid. The liver was very much enlarged, congested, cirrhotic, and covered with a thick, whitish, fibrinous deposit. The spleen was enlarged, and in the substance of the organ there were several large smoothly-rounded areas raised above the normal surface and white and caseous on section. The omentum was firmly attached to the spleen. The kidneys appeared to be normal. The mesenteric glands were enlarged, but not fused into one mass.

Bacteriological and Biological Investigation.—Examination of the mesenteric glands and fluids showed tubercle bacilli to be present in colossal numbers.

An emulsion of the mesenteric glands inoculated subcutaneously into a guinea-pig caused death from generalised tuberculosis in twenty-three days. Cultures from the glands were dysgonic. A rabbit inoculated subcutaneously with one milligram of the primary culture died of generalised tuberculosis in thirty-five days.

Case No. 10.—Adult male black cat. No history.

In very good condition and showed no skin lesions.

Post-mortem Examination.—The lungs were normal.

No ascites or inflammatory condition of the peritoneum, but the omentum was securely attached to the intestine in several places. The liver, spleen, and kidneys were found to be normal.

The mesenteric lymph glands were enlarged and fused together, forming a rounded mass 3 cm. in diameter. Parts of the intestine were so firmly

attached to this glandular mass that separation by careful dissection caused damage to the organs concerned.

Incision of the fused mass showed the central portion to be green, with a small area, about 4 m.m. in diameter, which was softened and yellow.

Bacteriological and Biological Investigation.—Smears from the yellow area of the mesenteric glands showed numerous tubercle bacilli. An emulsion of the mesenteric glands inoculated subcutaneously into a guinea-pig caused death from generalised tuberculosis in thirty-one days. Cultures from the glands were dysgonic. A rabbit inoculated subcutaneously with one milligram of the primary culture died of generalised tuberculosis in forty-two days.

Case No. 11.

Adult male mole-grey cat, in very good condition, showed only very slight swelling of the abdomen.

Post-mortem Examination.—The lungs showed a condition of miliary tuberculosis. The abdominal cavity presented a very extraordinary appearance. A large quantity of straw-coloured clear fluid was present. The liver was enlarged and the capsule covered with a whitish deposit. The spleen was very much enlarged, and quite changed in appearance. A portion about the size of the dorsal third of the normal organ had retained its usual colour, but the major portion had changed to a pale yellow and the tissue was exceptionally friable. The kidneys were slightly fatty. The omentum and mesentery were thickly coated with a fibrinous deposit. The fused mesenteric glands were enlarged, of a whitish-yellow colour, and very soft and friable.

Bacteriological and Biological Investigation.—Smears from the mesenteric glands, the deposit on the liver, and the ascitic fluid, showed large quantities of tubercle bacilli. An emulsion of the mesenteric glands inoculated subcutaneously into a guinea-pig caused death from generalised tuberculosis in twenty-nine days. Cultures from the glands were dysgonic. A rabbit inoculated subcutaneously with one milligram of the primary culture died of generalised tuberculosis in forty-seven days.

Discussion.

In all the three cases showing skin lesions the presence of tubercle bacilli in these was proved. In those with open lesions in the lungs and kidneys it was not possible to demonstrate the organisms in the sputum or the urine. It is a noteworthy fact that open lesions were present in six out of the eleven infected cats, and in another animal there was always the possibility of an open lesion in the intestine.

The high incidence of infection in the mesenteric glands is shown by these records, such lesions occurring in nine out of eleven positive cases, and it points to the intestinal tract as the portal of entry of the bacilli. Only in one out of the eleven cases (No. 1) was the obvious infection confined to the head and thorax. The ascitic fluid from this cat was not proved to be infected. The organisms recovered from all the cases were dysgonic, and caused in rabbits, after subcutaneous inoculation with a small quantity of bacilli, a rapidly fatal generalised tuberculosis.

The incidence of the disease amongst cats on the Continent,

quoted by workers in many countries, averages about 2 per cent., but Griffith (9) quotes Yost, working in 1913-1914 with cats that had been sent to the meat destructor in Berlin, as having found tuberculous lesions in 11 per cent.

This high percentage probably does not represent the average incidence of tuberculosis in cats in Berlin, as many of these animals may have been sent for destruction because they were obviously diseased and the destructor proved a convenient means of disposal. This would make the percentage incidence high, but not indicate the true extent of the disease in the cats of the city.

The work now reported has shown an average incidence of tuberculosis in the cat of 2 per cent., and draws attention to the cat as a source of infection for human beings, especially in the cases where open lesions are present or likely to develop. Cases 1, 3, and 8, with skin lesions from each of which tubercle bacilli were demonstrated in large numbers, would appear to have been particularly dangerous.

As far as one can judge from the records, the human type of the tubercle bacillus has not yet been shown to cause natural cases of tuberculosis in the cat.

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BRONCHIECTASES IN THE LUNG OF AN OX.

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The purpose of this article is to place on record an unusual example of bronchiectasis, affecting one entire lung of an otherwise apparently healthy ox slaughtered for food. Possibly similar lesions have been overlooked as to their true nature by those concerned with meat inspection.

Little reference can be found in veterinary literature to this condition in animals. Hutyra and Marek (Vol. ii, p. 586) say that " in the deeper portions of the lungs, especially in the anterior and lower parts, bronchiectasias are formed occasionally which are variable in shape (cylindrical, fusiform, sacciform), and which in large animals may assume the size of a fist. They always contain an abundant, dirty-greyish, mucopurulent secretion, which is occasionally fœtid." " The exudate and, later on, the bronchial wall itself decompose with the development of a dirty-greenish colour and a fœtid smell." On p. 590 they refer to " the rare cases of bronchiectasias," and on p. 606 say that " bronchiectases of varying sizes are rarely missed in the presence of worms."

In human pathology bronchiectases are recognised as being local or generalised, and as being cylindrical, fusiform, varicose, or sacculated, the type last mentioned being associated with a fibrosis of the lung. The causes are ascribed to weakened bronchial walls combined with increased pressure within the bronchi, either from accumulated secretions or forced inspirations following coughing. A fibrosis or interstitial pneumonia helps to dilate the bronchi by the traction of the contracting fibres connected with the bronchial walls. A feature of the sacculated type in man is the fœtid decomposition of the accumulated secretions, with the epithelial lining not infrequently gone, and frequently the presence of inflammation in all stages up to ulceration of the lining membrane. The muscle, glands, and cartilage of the bronchial tubes may have atrophied, and even disappeared. The epithelium of the dilated bronchi, when present, may be flattened and in several layers.

The lung about to be described was sent to us from the Woodside Lairage, Birkenhead. It was taken from an Irish ox whose carcase was examined and passed for food. The carcase and organs were free from tuberculosis. Only one lung was abnormal; indeed, the animal could not have lived unless the other lung had been functioning properly because the abnormal lung was totally devoid of air. The message received was that the lung was seized as being " affected with abscesses."

The lung as received was very heavy, and would certainly have sunk quickly in water. At first sight the organ seemed to be full

of abscesses of varying size, but incision showed the " abscesses " to have very mucoid contents, and smears of the contents showed a complete absence of bacteria on microscopic examination. There was no evidence of decomposition or smell from the contents of the cavities. The entire lung was involved, even to the thinnest portions of the organ. A large piece of the lung was incised and fixed for museum purposes, and subsequently portions of the wall of larger and smaller cavities were taken for histological examination, and it was from these that the accompanying illustrations were prepared.

Fig. 1 shows very clearly the cylindrical and saccular dilations of the bronchi and bronchioles. Some of the cavities have had their outer wall removed, and the contents washed out to show their extent, and a piece of black ivorine has been inserted along a bronchus, and passed through the base of a large saccular dilatation. The ridges encircling the cylindrical dilatations are well shown, and are due to the uneven dilatation of the bronchiole. No lung tissue was evident macroscopically in the piece of lung photographed. The somewhat shrunken appearance is due to the tissue having been photographed after fixation.

Fig. 2 shows the same piece of lung in cross section. The absence of any macroscopic evidence of lung tissue is to be noted, the lung consisting of dilated bronchial tubes with fibrous tissue in between. Here again the contents of most of the cavities were washed out in order that the picture might show the cavities, but in several cavities towards the right of the lower half of the picture the mucoid and catarrhal contents are seen *in situ*.

Fig. 3 shows a cross-section of lung under a low magnification ($\times 10$). The figure illustrates the fate of the lung parenchyma. The cavities are lined by intact columnar epithelium.

Fig. 4 shows across its centre a line of intact columnar ciliated epithelium, and just below two small pieces of plain muscle. With the exception of a little lymphoid tissue all the tissue under the epithelium is fibrous tissue. At the top of this illustration is seen the contents of the cavity, consisting of mucus secretion poor in cells.

The cause of the condition described is left a matter for surmise.

FIG. 1.

Described in the text.

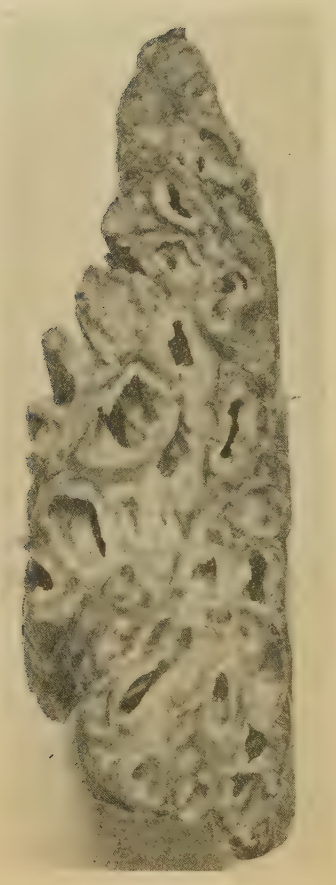

FIG. 2.
Described in the text.

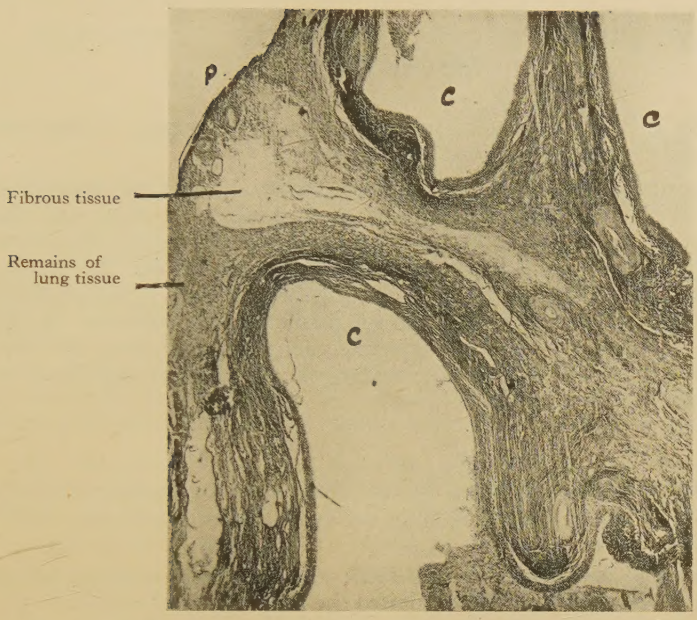

FIG. 3.
P. Pleural surface. C. Cavities of dilated bronchi. Magn. × 10.

FIG. 4.
Described in the text. Magn. × 90.

REVIEWS.

Enzymes. By J. B. S. Haldane. Monographs on Biochemistry, Longmans Green and Co., Ltd., London, 1930. 14s. net.

This book does not claim to be a complete treatise, but consists essentially of a survey of modern work on enzymes. It is mainly concerned with the kinetics of enzyme reactions and gives a full account of the effects of enzyme and substrate concentrations, hydrogen ion concentrations, and the mathematical theory of the course of reactions catalysed by enzymes. Later chapters deal with recent work on specificity and the purification of enzymes. A full bibliography is appended. The biologist and the physical chemist will both be grateful to the author for his able review of current work and ideas in this important field.

Handbook for Veterinary Surgeons. By Fred Bullock, LL.D., Barrister-at-Law. Second Edition. London: 1930. Baillière, Tindall and Cox. Price 5s. 4d. post free.

This work was first published in 1927, and it is very satisfactory to learn that the demand for it has necessitated the preparation of a second edition. The latter is almost double the size of the first, and the new matter adds greatly to its value. The comprehensive character of the information given in the book may be inferred from the titles of its principal chapters: Administration of the Profession, Rights and Duties, Professional Conduct, Legal Responsibilities and Duties, Post-Graduate Studies, Taxes and Insurance, Government Services.

The work is mainly designed for recent graduates, and for them it may without exaggeration be said to be indispensable, but it can be most strongly recommended to all members of the profession, whether engaged in ordinary practice or employed in the public service.

ELEVENTH INTERNATIONAL VETERINARY CONGRESS.

LONDON, AUGUST 4TH TO 9TH, 1930.

RESOLUTIONS.

AT the closing meeting of the Congress, held on Saturday, August 9th, 1930, the following Resolutions were passed.

I. Official Languages.—That for future Congresses the official languages remain as at present, viz.: English, French and German, but that, if found possible, the summaries of reports may be translated also into Italian and Spanish.

II. Date and Place of Next Congress.—That the invitation of the American Veterinary Medical Association for the next Congress to be held in the United States of America, probably at Boston, in the year 1934, be accepted.

III. Foot-and-Mouth Disease.—That, in the opinion of the Congress:

(*a*) The establishment of the existence of a plurality of viruses of foot-and-mouth disease is of the highest significance in relation to the epizootiology of the disease and to methods of active and passive immunization.

(*b*) It is highly desirable that in all countries the type of virus present should be determined in all primary outbreaks.

(*c*) In respect of disinfection, it should always be remembered that both the diseased animals and the buildings constitute a serious danger in the spread of the disease.

(*d*) The most efficient disinfecting agents are moist heat and sunlight and, of chemical agents, potassium and sodium hydrates and formalin.

(*e*) The value of passive immunization has been established, and its use in practice in favourable circumstances is to be encouraged.

(*f*) It is highly desirable that all possible efforts should be made to discover an efficient method of active immunization.

IV. Infectious Abortion of Sheep, Cattle and Swine. (*a*) That scientific investigations regarding contagious bovine abortion are essential in all civilised countries, particularly for the purpose of controlling the disease, the preparation of an effective method of immunization, the elucidation of the rôle of *Bacterium abortus* Bang as a cause of disease in man, and determining the relationship between the disease caused by this organism in man and Malta fever.

(*b*) That, in view of the very widespread occurrence of infectious abortion of cattle in all civilised countries, an international scientific investigation should be carried out, and that such an investigation would come within the purview of the Office International des Epizooties de Paris.

V. Relationship of the Veterinary Surgeon to Animal Husbandry.—That, in view of its importance to the welfare of the public, Animal Husbandry (Zootechny) should be given a prominent position in the programme of every future Congress.

VI. Veterinary Science in Relation to Public Health, with Special Reference to Production and Distribution of Meat and Milk.—That at the next Congress a special Section for Meat and Milk Hygiene should be created.

VII. The Law Governing the Practice of Veterinary Medicine and Surgery.—

(*a*) That the Congress urges upon Governments the necessity for legislation

giving to the veterinary profession such power as will enable it to exert a uniform control over the health of domestic animals.

(*b*) That the title of Veterinary Surgeon ought to be legally protected, and that only those should be authorised to practise animal medicine who possess a diploma granted or recognised by the State.

VIII. Anthrax.—(*a*) That in the general interest of Public Health in all countries it is an indispensable duty to take effective precautions against the infection of human beings and animals with Anthrax by animal products, such as bones, bonemeal, and hides, containing the germs of the disease.

(*b*) That regulations are urgently needed to prevent the trade in raw materials from animals dead of Anthrax. If the laws in force in an exporting country are not sufficient for this purpose, it is essential that the suspected products should be tested or sterilised in the importing country before they are allowed to pass into general trade.

(*c*) That only an exposure to steam under pressure for several hours can at the present time be considered satisfactory for the thorough disinfection of animal products infected with Anthrax.

IX. Standardisation of Biological Products.—That the attention of the Office International des Epizooties de Paris be drawn to the urgent necessity of a prompt consideration of the question of the standardisation of biological products.

X. Diseases of the New-Born.—That, having regard to the good results of the organisation for combating diseases of the New-born in Germany, the Congress recommends that in all countries similar organisations should be established, with a view to the formation of an International Union for that purpose, to which each country would furnish annual reports for circulation to all countries concerned.

XI. Rinderpest.—That this Congress considers that sufficient knowledge of practicable methods is now available to eradicate Rinderpest within a reasonable period of time in any country which will provide adequate facilities for their application, and urges upon all Governments to co-operate to this end.

XII. Fowl Typhoid and Bacillary White Diarrhœa.—That, in the opinion of this Congress, the method of diagnosis and prophylaxis of Bacillary White Diarrhœa of Chickens by systematic agglutination tests, carried out by qualified veterinarians, is at the present moment the procedure most to be recommended.

XIII. Genetics.—(*a*) That Veterinary Schools and Veterinary Institutes should be provided with the scientific and experimental facilities necessary for the proper teaching of Zootechnics.

(*b*) That the necessary funds for carrying out experimental researches should be accorded to the teaching staffs.

(*c*) That as far as possible the services of Veterinary Surgeons should be utilised in applying the measures designed to improve animal husbandry.